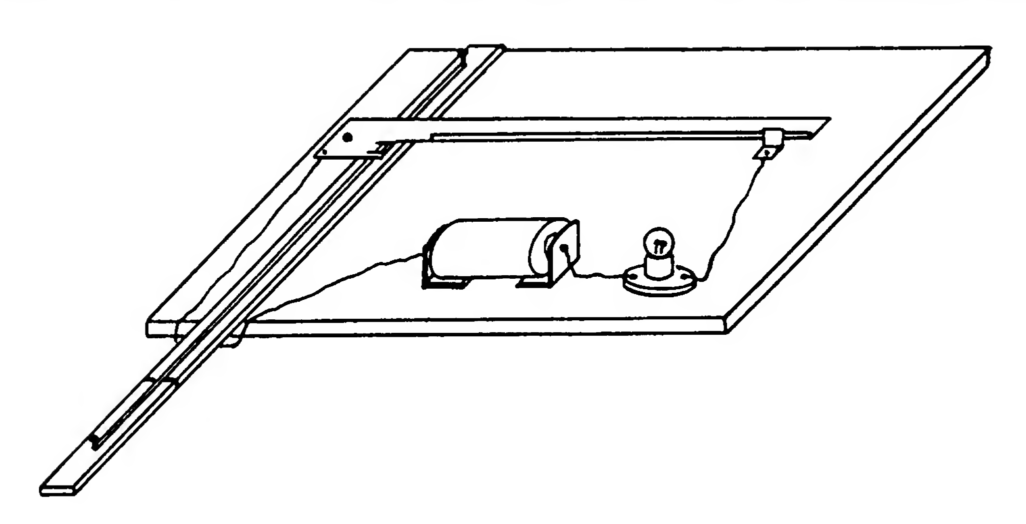
LOW COST EQUIPMENT for science and technology education

A Resource Document on low cost equipment that you can make and use.



ED.85/WS.60

Unesco

LOW COST EQUIPMENT for science and technology education

ED.85/WS.60



PREFACE

This resource document on low-cost equipment for science and technology education consists of a collection of apparatus designs. Its purpose is to provide technical information and simple instructions for the construction of a range of widely-used items of school science equipment, using inexpensive materials.

The designs have been submitted by the following institutions:-

Fundaçao Brasileira para o Desenvolvimento do Ensino de Ciências (FUNBEC), Cidade Universitaria, U.S.P. Caixa Postal 2089, S. Paulo, Brazil.

Science Equipment Centre, Federal Ministry of Education, Ijanikin, Lagos, Nigeria.

National Educational Equipment Centre, Wahdat Colony, Lahore, Pakistan.

School Science Equipment Development Project, National Institute of Science and Technology, P. O. Box 774, Manila, Philippines.

The Institute for the Promotion of Teaching Science and Technology (IPST), 924 Sukhumvit Road, Bangkok 11, Thailand.

The material has been compiled and edited by Mr. N. K. LOWE.

From this first resource document on low-cost equipment we should like to receive your assistance and suggestions. Please inform us of any difficulties you may have experienced in constructing and using the designs. Also let us know if you have found them useful and how you used them in the learning environment.

In the event of an accident occurring through the use of any of the items, neither Unesco nor the editor or the submitting institutions can accept any responsibility.

Should you have a design which may be suitable for publication in future issues of this document or elsewhere, please send it, preferably in the format used in this document to:

Division of Science, Technical and Environmental Education,
UNESCO,
Place de Fontenoy,
75700 Paris,
France.

CONTENTS

1. ALCOHOL BURNER.
2. KEROSENE BURNER.
3. TEST TUBE RACK, WOODEN.
4. TEST TUBE RACK.
5. TEST TUBE RACK.
6. TRIPOD STAND.
7. HALF-METRE DISC.
8. SIMPLE GAS GENERATOR.
9. FIRE EXTINGUISHER.
10. MOLECULAR MODEL OF CO_2
11. ENVIRONMENTAL GAME.
12. SIMPLE BALANCE.
13. SIMPLE MOMENTS BALANCE.
14. ELEMENTARY BALANCE.
15. TWO PAN BALANCE.
16. SIMPLE MICROSCOPE.
17. GLASS BEAD MICROSCOPE.
18. ARTIFICIAL LUNGS.
19. WORKING MODEL OF LUNGS.
20. AQUARIUM TANK.
21. DISSECTING NEEDLE.
22. DISSECTING BOARD.
23. STRECTCHING BOARD.
24 ELEMENTARY COUNTING DISC.
25. SIMPLE ABACUS.
26. MATHEMATICAL MODEL.
27. MODEL OF A CIRCLE
28. RIGHT ANGLED TRIANGLE MODEL.
29. COUNTING TRAY TO BASE 5.
30. SET OF ATTRIBUTE BLOCKS - GEOMETRIC MODELS
31. FRICTION BLOCK.
32. SIMPLE PULLEY
33. CENTRE OF GRAVITY SET.
34. WEIGHTLESSNESS APPARATUS.
35. DYNAMOMETER..
36 SPRING BALANCE
37. REACTION FORCE APPARATUS.

38. SIMPLE ACTION AND REACTION CART.
39. EQUIPMENT FOR MECHANICAL RESONANCE STUDIES.
40. AIR AND WATER WHEEL.
41. LOW COST SUBMARINE.
42. CARTESIAN DIVER APPARATUS.
43. 'U' TUBE - HARE'S APPARATUS.
44. 'U' TUBE MANOMETER.
45. SIMPLE 'U' TUBE MANOMETER.
46. BIMETAL STRIP.
47. EXPANSION APPARATUS.
48. LINEAR EXPANSION OF WIRE APPARATUS.
49. EXPANSION APPARATUS.
50. APPARATUS FOR THE EXPANSION OF LIQUIDS.
51. STEAM TURBINE APPARATUS.
52. STEAM TURBINE.
53. ROTATING VANE APPARATUS.
54. WHAT CAUSES WIND APPARATUS.
55. HEAT ABSORPTION APPARATUS.
56. HEAT CONDUCTIVITY APPARATUS.
57. APPARATUS FOR HEAT CONDUCTIVITY OF METALS.
58. SIMPLE CALORIMETER.
59. CALORIMETER.
60. RESONANCE TUBE APPARATUS.
61. EXPLORATION OF SOUND APPARATUS.
62. A SOUND KIT.
63. REFLECTION OF SOUND APPARATUS.
64. LIGHT SOURCE FOR OPTICS EXPERIMENTS.
65. PIN HOLE CAMERA.
66. MODEL OF A TELESCOPE.
67. PERISCOPE.
68. LIGHT REFLECTION BOX.
69. REFRACTION AND REFLECTION OF LIGHT APPARATUS.
70. MODEL OF THE SOLAR SYSTEM.
71. MODEL TO DEMONSTRATE ECLIPSES.
72. ASTRONOMY MODEL- GREAT BEAR, LITTLE BEAR, CASSEOPEIA, POLE STAR.
73. MOVING PICTURE DISC.
74. BATTERY HOLDER.

75. SIMPLE SWITCH.
76. ELECTROSCOPE.
77. ELECTROSCOPE.
78. MODEL FOR THE DETERMINATION OF THE POLES OF A MAGNET.
79. MAGNETIC COMPASS.
80. SIMPLE COMPASS GALVANOMETER.
81. SIMPLE GALVANOSCOPE (GALVANOMETER)
82. GALVANOMETER.
83. ELECTRIC MOTOR.
84. SIMPLE D.C. ELECTRIC MOTOR.

INTRODUCTION

The apparatus designs in this collection may be familiar to some, and new to other readers. They are not necessarily unique to the insititutions who have submitted them, but they are accredited to them since it is believed that the designs have been found useful in the countries in which the institutions are located. For the purpose of this document the designs have been edited, where necessary, to provide either a clearer drawing or text. The designs have been prepared in such a manner that they can be easily removed and photocopied/reproduced for use in teaching-learning activities.

In most cases the apparatus can either be prepared by the teacher, or constructed by the pupils as part of a construct-and-use programme of learning. Very little initial practical skill is required for the construction of the items; in fact, basic skills in woodworking, metal working etc. could be developed from the construction of the items as part of a modular science and technology programme of learning.

No attempt has been made to standardise the drawings according to Graphical Communications presentation. The sketches have been prepared (generally as received) to provide maximum presentation within a limited space, and also to provide a 'picture' of the item. It would be possible to utilise the sketches in a formal Graphical Communications learning situation whereby the pupils use the designs and re-prepare them as if for use in an equipment production workshop.

Terms Used

Generally, technical terms have been kept to a minimum in favour of easily read and understood descriptions. The following may help to clarify any possible non-familiarity with some of the terms used:-

Diameter	shown as dia., or Dia., or Ø
Radius	shown as rad., or Rad., or R
Dimensions	usually in millimetres (mm) or centimetres (cm)
Styrofoam	a commercial term for expanded polystyrene as found in packing cases containing sensitive equipment, or as ceiling tiles. Sometimes also known as Polystyrene.
Scotch tape	also known as Sellotape.
Epoxy Resin Adhesive	a commercial version, marketed under the name of 'Araldite' is found in many parts of the world.

Caution

All items requiring an electrical supply for operation are for use on dry cell torch batteries. They must not be connected to a low-volt power pack or the electrical main supply.

USEFUL TOOLS AND TECHNIQUES

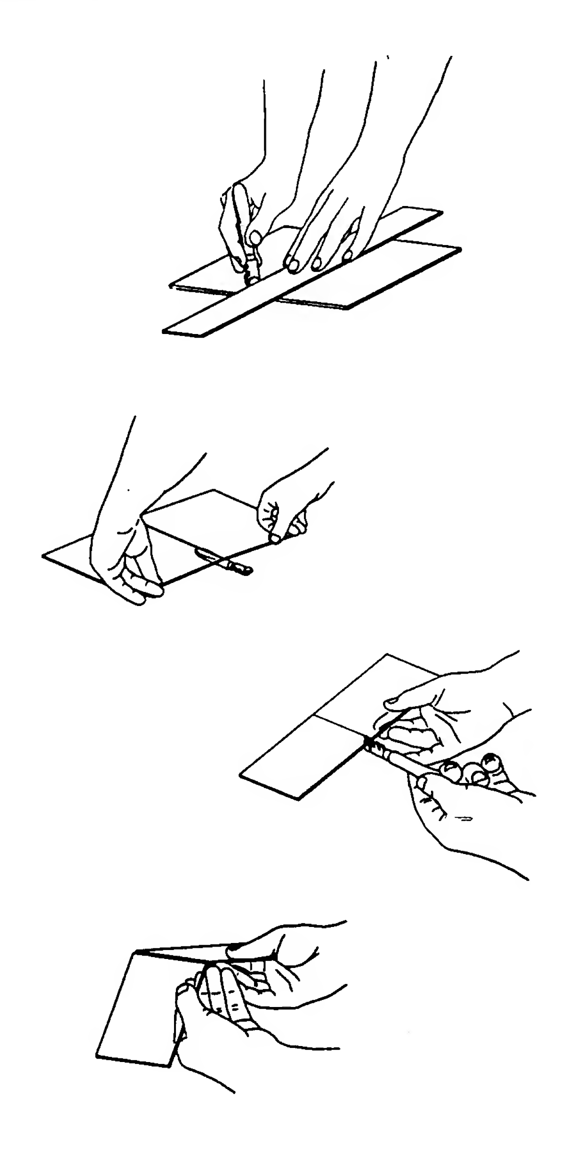
Tools

Clever experimenters can achieve a very high standard of workmanship with a surprisingly small number of tools. It is impossible to say that certain tools form a minimum amount of equipment. In any case, the experimenter will probably acquire his equipment stage by stage and need not be deterred from starting a project because of some particular lack. As a beginning aim at acquiring the following:

Metalworking tools: vice, hack-saw, hammer, screwdrivers, pliers (flat and round nose), cutting nippers, electric or other soldering iron, electric drill, twistdrills, taps and dies, various files, scriber.

Common woodworking tools: chisels, common saw, rip saw, steel plane, modern rasp or rasp plane, brace and bits, a variety of glues and cements, paints in various colours.

Glass cutting



1.1 *Making a straight cut*

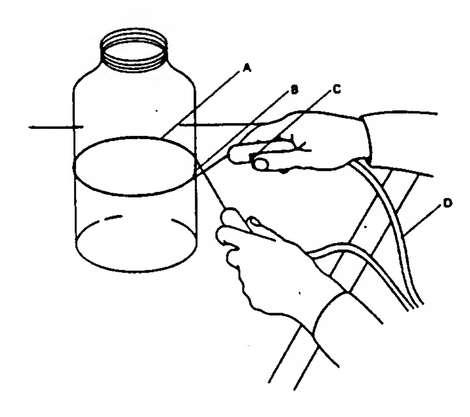
A glasscutter does not cut glass, but splits it with a tiny wheel. If the wheel is sharp and it is drawn over the glass at the right speed and pressure, it makes a fine score or groove by slightly crushing or pulverizing the glass. The bevelled sides of the wheel act as wedges which push against the sides of the groove and pry the glass apart so that a crack is started. If a crack fails to start, tap the scratch or score with the ball end of the glasscutter. Before trying to make a finished cut, practise on a scrap piece to learn the speed and pressure required to obtain a smooth edge (see figure); Ordinary window glass comes in two thicknesses, single light and double light. Single light is thinner and easier to cut. Plate glass up to 0.6cm in thickness can be cut in the same manner as ordinary window glass. Safety glass which consists of two or more glass sheets cemented together by a transparent plastic, requires special cutting equipment.

1.2 *Cutting glass tubing*

One way to cut glass tubing is to score the surface with one forward stroke of a three-cornered file. The corner of a mill file will also work well. Make the score mark at right angles to the centre line of the tube so that the tube will snap squarely across. To snap the tube, place it on the bench top with a matchstick or toothpick directly beneath the upward-facing score mark. Then, holding one end securely, press down on the other end and the snap will be immediate. Another method frequently used is to scratch the glass tubing with a quick smooth file stroke, then hold the scratched tubing firmly in both hands with one's thumbs pointing towards each other (but on opposite sides of the scratch) and snapping the glass tubing away from one's body. Fire-polish the cut ends.

1.3 *Resistance wire glass cutter*

Obtain about 60cm of 24-gauge nichrome wire, and improvise heat-proof handles (one with a switch) for the ends. Connect to a suitable 12-V 5-A power supply (a car battery, or step-down transformer). Make sure that the leads and the switch are strong enough for the current to be carried. The wire should become red hot a few seconds after switching on. If it does not, first check the power supply and the connexions. It may be necessary to reduce the length of the resistance wire if it still does not get hot enough. Now file a small groove on the glass jar where the nichrome wire will cross. Adjust the wire in a loop on the desired position for cutting. Keep the wires from touching where they cross in the groove. Switch on, and after a few seconds, the glass will usually crack in a clean cut where the wire has looped the jar. If this does not happen after 15 to 20 seconds, switch off, quickly remove the nichrome-wire loop and hold the jar under running water. This will cause the necessary contraction to break the jar on the desired line. Use caution during the actual breaking operation (see figure).



Resistance wire glass cutter
A 24 gauge nichrome wire
B small notch filed in side of bottle
C switch in handle
D connecting cable to supply source

The above is reproduced from the New Unesco Source Book for Science Teaching, Paris, Unesco, 1973. Other Unesco publications containing equipment designs and related information are:

Unesco Handbook for Science Teachers, Paris, Unesco, 1980.

New Trends in School Science Equipment, Paris, Unesco, 1983.

Low Cost Equipment for Science Teaching, Santiago, Chile, Unesco Regional Office for Education in Latin America and the Caribbean, 1984.

Improvisations in Science - A Handbook for Teachers, Santiago, Chile. Unesco Regional Office for Education in Latin America and the Caribbean, 1985, (previously published by the Ministry of Education, Kingston, Jamaica, 1981).

Low-cost Educational Materials, Vols I, II and III, Bangkok, Thailand, Unesco Regional Office for Education in Asia and the Pacific, 1984.

1- ITEM

ALCOHOL BURNER.

2- PURPOSE

For heating.

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project,
National Institute of Science and Technology, Manila, Philippines

4- LINE DRAWING OF PROTOTYPE

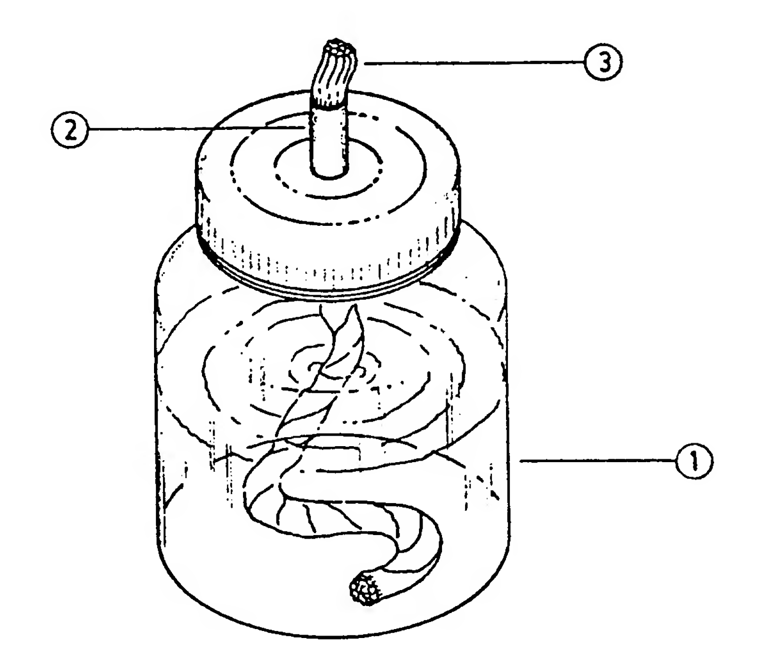


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Glass jar	1	Empty glass bottle.	60mm Ø x 72mm,approx.
2- Wick holder	1.	aluminum tube.	7mm Ø x 25mm.
3- Wick.	1.	Floor mop strand.	100mm long.
		Epoxy cement.	

6- CONSTRUCTION DETAILS

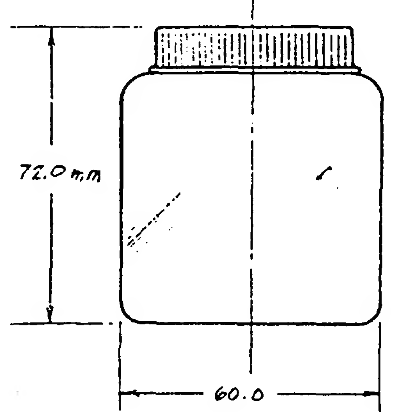


Fig. 1. Obtain a screw lid bottle of approximately the sizes indicated.

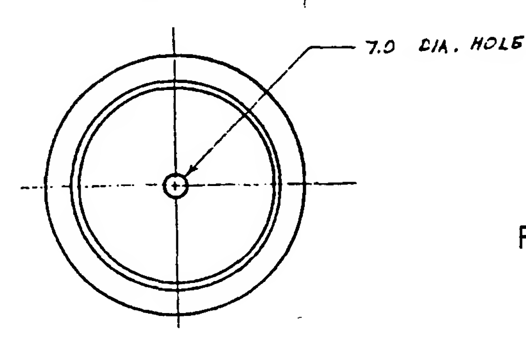


Fig. 2. Drill a 7mm diameter hole in the lid.

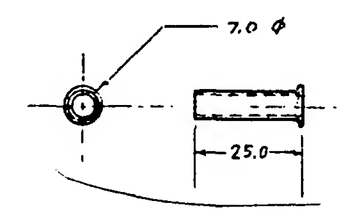


Fig. 3. Cut a 25mm length of 7mm outside diameter aluminium tubing and open out one end as shown.

Insert the tube through the hole in the lid of the bottle and fix in place using epoxy cement. Insert the wick (made from cotton floor mop strands) into the tubing.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50.

8- METHOD OF USE

Fill the glass jar about three-quarters full of alcohol; also wet the tip of the wick with alcohol before lighting.

9- COMMENTS

Short bottles are preferred for stability on the table.

1- ITEM

KEROSENE BURNER

2- PURPOSE

Use of a kerosene burner in place of a spirit lamp in the laboratories.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

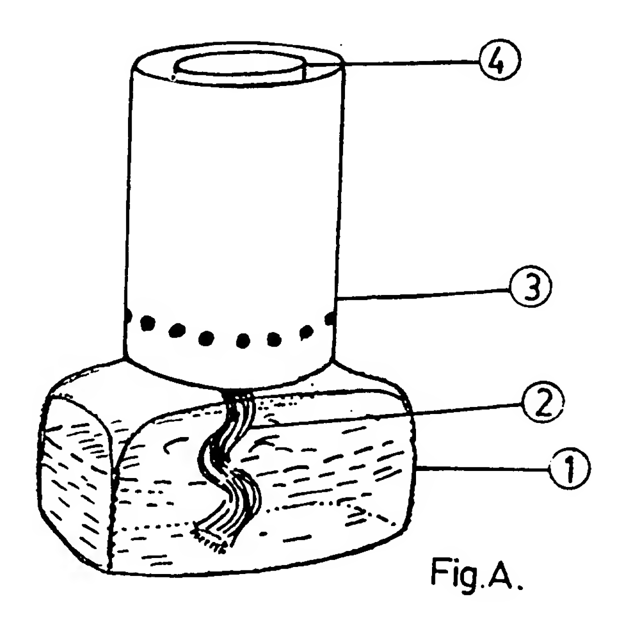


Fig. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Container.	1.	Ink bottle (glass) with metallic lid.	
2 - Cotton wick.	1.	Strands from floor mop.	
3 - Outer tin chimney.	1.	Tin sheet.	dia. 35mm, 65mm long.
4 - Inner tin chimney.	1.	Tin sheet.	dia. 25mm, 60mm long.
5 - Wick pipe.	1.	Tin sheet.	dia. 5mm, 30mm long.

Tools: Drilling machine, tin snips, marker, hammer, pliers, drills.

6- CONSTRUCTION DETAILS

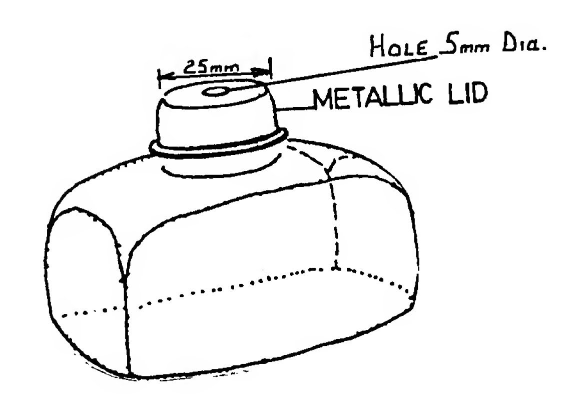
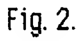


Fig. 1.

Take the metallic lid of the ink bottle and drill a hole of 5mm dia. with the help of the drilling machine.



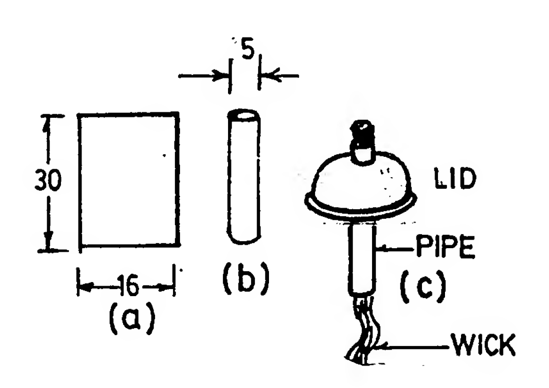


Fig. 2.

Using the tin snips cut a tin strip of size 30mm x 16mm as shown in 2.a. and, using the pliers, bend it to make the Wick Pipe of 5mm dia. x 30mm long as shown in 2.b. Fix the tube with the wick in place in the lid as shown at 2.c.

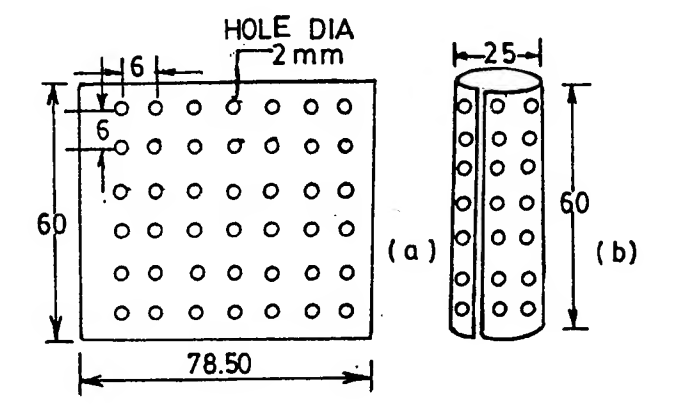


Fig. 3.

Using the tin snips cut the tin sheet of size 78.5mm x 60mm. Using the drilling machine drill holes of size 2mm dia. according to the dimensions shown at 3.a. With the help of the pliers bend the sheet to make the inner chimney of dia. 25mm x 60mm long as shown at 3.b.

6- CONSTRUCTION DETAILS (Continued)

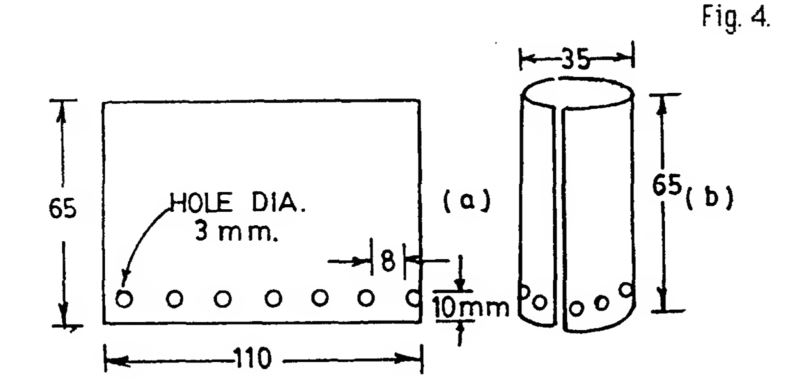


Fig. 4.

Using the tin snips cut a tin strip of size 110mm x 65mm. Drill holes of 3mm dia. as shown at 4.a. Bend the strip to form the outer chimney of dia. 35mm x 65mm long as shown at 4.b.

7- APPROXIMATE COST OF ONE ITEM (in US $)

$1.00.

8- METHOD OF USE

Pour some kerosene oil into the ink bottle and fix the lid assembly onto it. Fix the inner and outer chimneys to the bottle to make the burner as shown in Fig. A.

Light the burner with a match. After 2 or 3 minutes the burner will give a hot blue flame which can be used for heating purposes in science laboratories.

9- COMMENTS

1- ITEM

WOODEN TEST TUBE RACK.

2- PURPOSE

To hold test tubes during experiments and to store the same afterwards.

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project,
National Institute of Science and Technology, Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

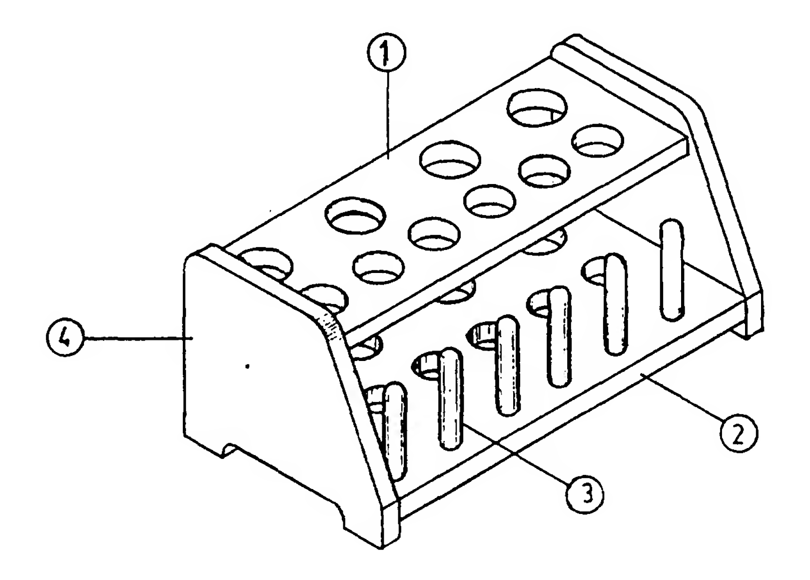


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Top test tube support.	1.	Plywood.	210mm x 80mm x 12.5mm
2 -Bottom test tube support.	1.	Plywood.	210mm x 108mm x 12.5mm
3 - Pegs.	6.	Wood.	12mm dia x 55mm long
4 - End pieces.	2.	Plywood.	108mm x 100mm x 12.5mm
		Nails.	
		Glue.	

6- CONSTRUCTION DETAILS

Fig. 1.

Cut the plywood to the sizes indicated and drill the holes.

Fig. 2.

Cut the plywood to the sizes indicated and drill the holes.

Fig. 3.

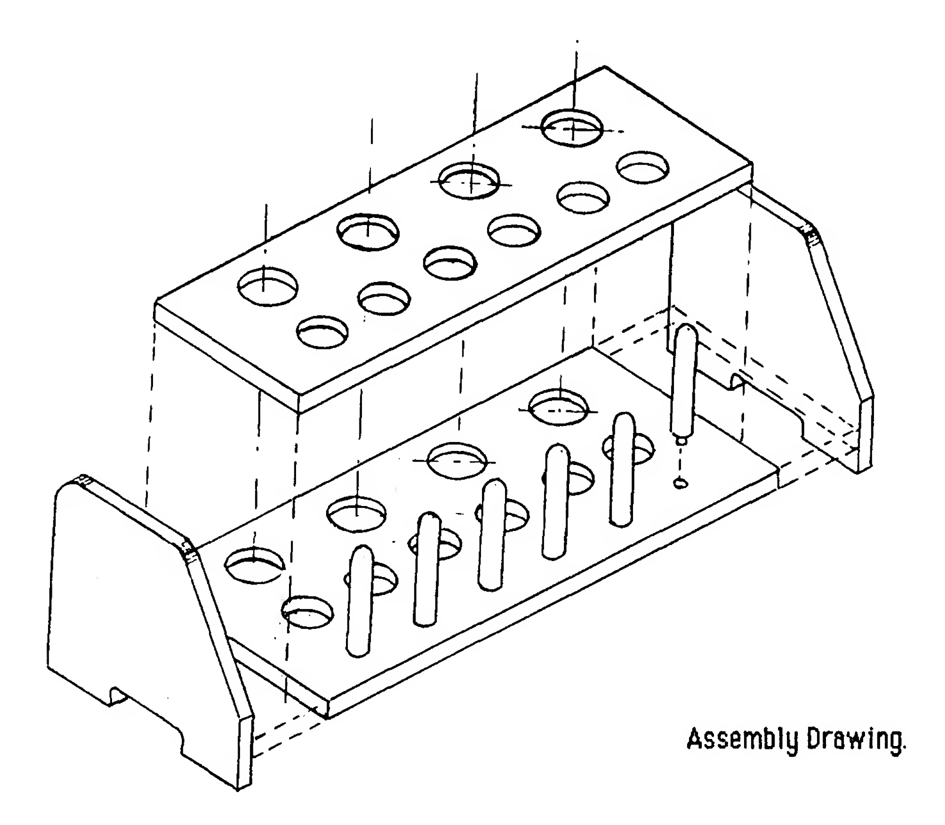
Cut the wood dowelling to the sizes shown. Reduce the diameter at one end and round off the other end.

Fig. 4.

Cut the plywood end pieces to the size and shape indicated.

Sandpaper all surfaces to a smooth finish before commencing the assembly.

6- CONSTRUCTION DETAILS (Continued)



Assembly Drawing.

After smoothing down all surfaces assemble the parts, using nails and glue, as shown in the above assembly drawing.

7- APPROXIMATE COST OF ONE ITEM (in US $)

$2.50.

8- METHOD OF USE

As with other test tube holders. Test tubes may be stored or allowed to dry on the wooden pegs.

9- COMMENTS

The assembled apparatus should be coated with varnish or paint to minimise the absorption of water.

1- ITEM

TEST TUBE RACK.

2- PURPOSE

For holding test tubes upright during and after an experiment.

3- INFORMATION SUBMITTED BY

Science Equipment Centre, Lagos, Nigeria.

4- LINE DRAWING OF PROTOTYPE

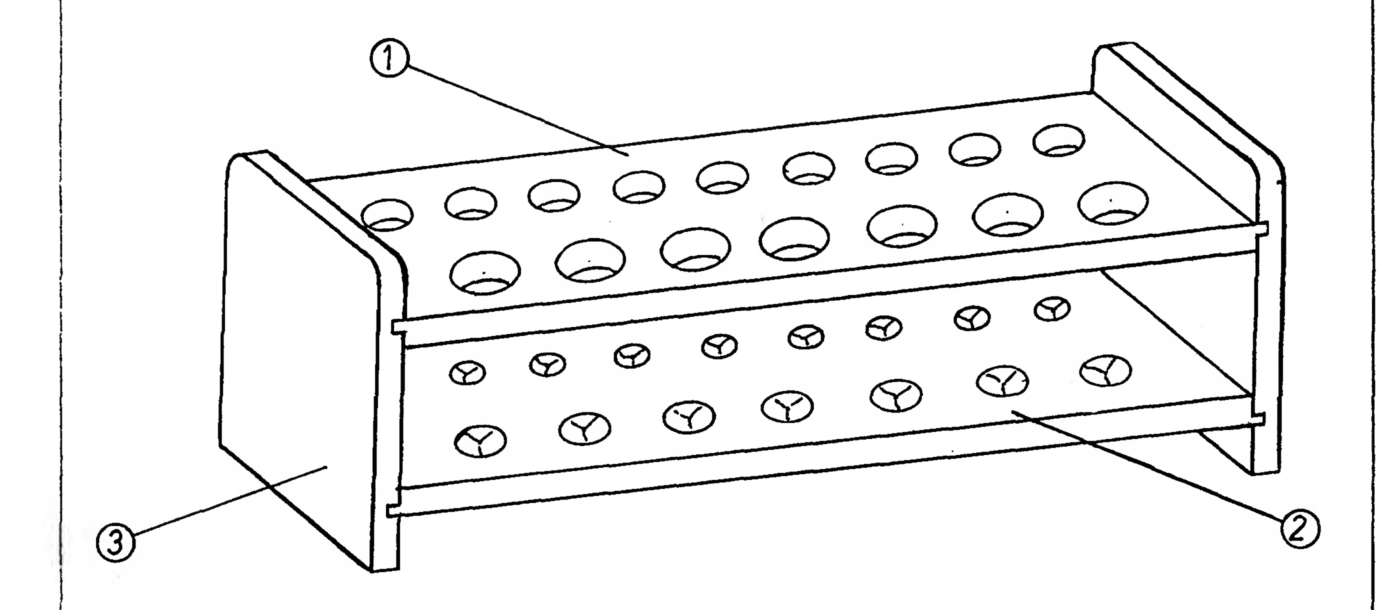


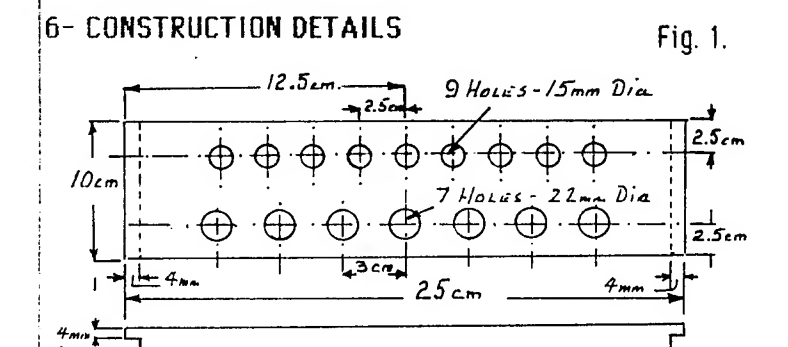
FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Top.	1.	Wood.	25cm x 10cm x 1cm
2 - Base.	1.	Wood.	25cm x 10cm x 1cm
3 - Sides.	2.	Wood.	12cm x 10cm x 1cm
		Glue.	
		Varnish.	

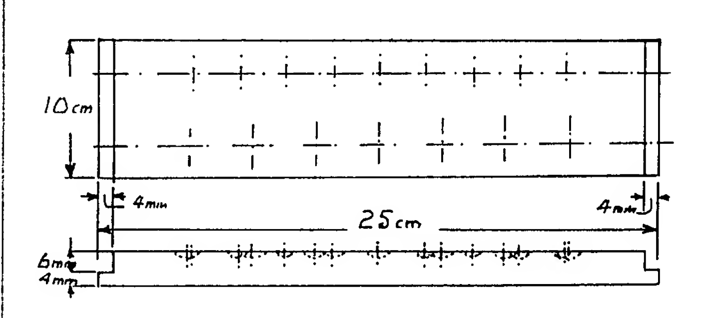
6- CONSTRUCTION DETAILS

Fig. 1.



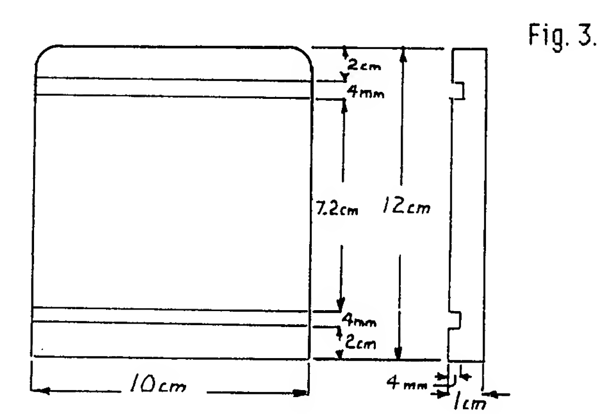
Cut the top piece to the dimensions given. Mark out and drill two rows of holes according to the diameter of the test tubes available.

Fig. 2.



Cut the bottom piece to the dimensions given. Note that the end tenon joint is opposite to that in the top piece. Place the top piece on the bottom piece and, using the same drills as for the top piece, 'dimple' the bottom piece just deep enough to steady the bottom of the test tubes.

Fig. 3.



Cut the side pieces to shape. Mark out the positions for the grooves and cut them. The tenons at the end of the top and bottom pieces should be a tight push fit into the grooves.

Smooth down all surfaces with sandpaper and glue the sides to the top and bottom pieces. Finally varnish all surfaces.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

8- METHOD OF USE

9- COMMENTS

Other designs are available to which dowel pins are fixed on one side. These serve as supports for used test tubes in an inverted position for drying after washing.

1- ITEM

TEST TUBE RACK

2- PURPOSE

To provide a simple test tube rack.

3- INFORMATION SUBMITTED BY

The Institute for the Promotion of Teaching Science and Technology (IPST), Bangkok, Thailand.

4- LINE DRAWING OF PROTOTYPE

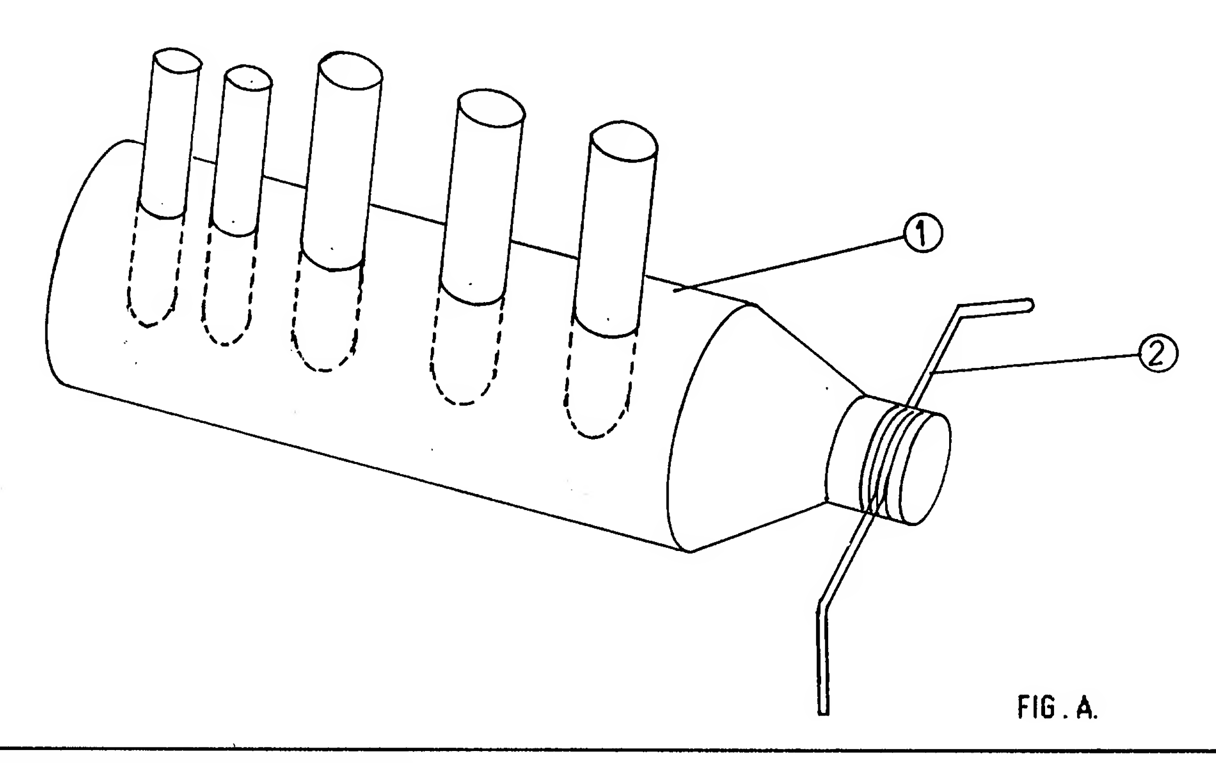


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Body.	1.	Plastic bottle.	---
2- Stand	1.	Metallic wire.	---

6- CONSTRUCTION DETAILS

Clean the bottle and make holes to put the test tubes in by using a hot iron rod. Wind the metal wire around the neck of the bottle to make the stand, as shown in Fig. A., to keep the test tubes upright.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

under $1.00.

8- METHOD OF USE

9- COMMENTS

1- ITEM

TRIPOD STAND

2- PURPOSE

Support for heating in laboratories

3- INFORMATION SUBMITTED BY

Science Equipment Centre, Lagos, Nigeria.

4- LINE DRAWING OF PROTOTYPE

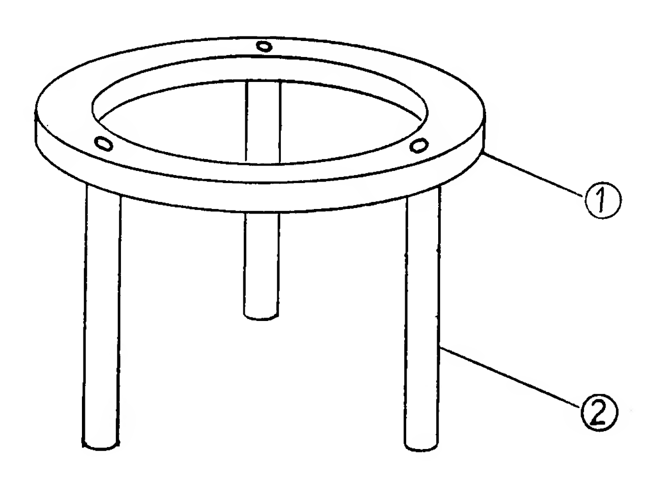


FIG . A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Ring.	1.	Mild steel plate.	13cm x 13cm x 4mm.
2- Legs.	3.	Mild steel rod.	6mm dia x 17cm long.

6- CONSTRUCTION DETAILS

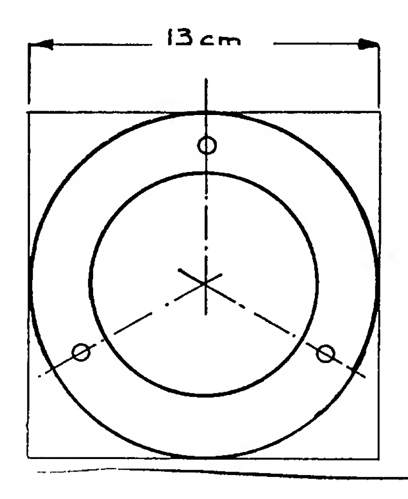


Fig.1. Mark out the ring on the steel plate according to the dimensions shown. Also mark out the positions for the three holes for the tripod legs equidistant apart.
Cut out the ring by cutting just inside the inner circle and just outside the outer circle. Using a round or half round file, file the ring to size and remove all sharp edges.
Drill the three holes for the legs, and countersink them.

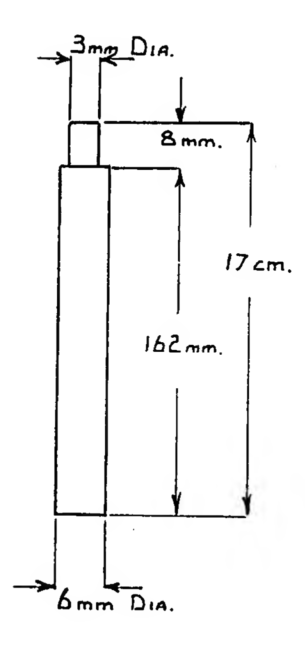


Fig. 2. Prepare the legs by reducing the diameter at one end according to the dimensions shown.

To complete the tripod place one leg into a drilled hole and, holding the leg in a vice, rivet the leg to the ring using a hammer. Repeat for the other two legs.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$4.00

8- METHOD OF USE

Direct heating of flasks, beakers, etc. in the laboratory.

9- COMMENTS

The tripod stand should be properly cleaned with cloth and oiled lightly to avoid rust. Alternatively it could be painted with black heat-proof paint or aluminium paint.

1- ITEM

HALF METRE DISC

2- PURPOSE

To construct a scale and measure distances

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan

4- LINE DRAWING OF PROTOTYPE

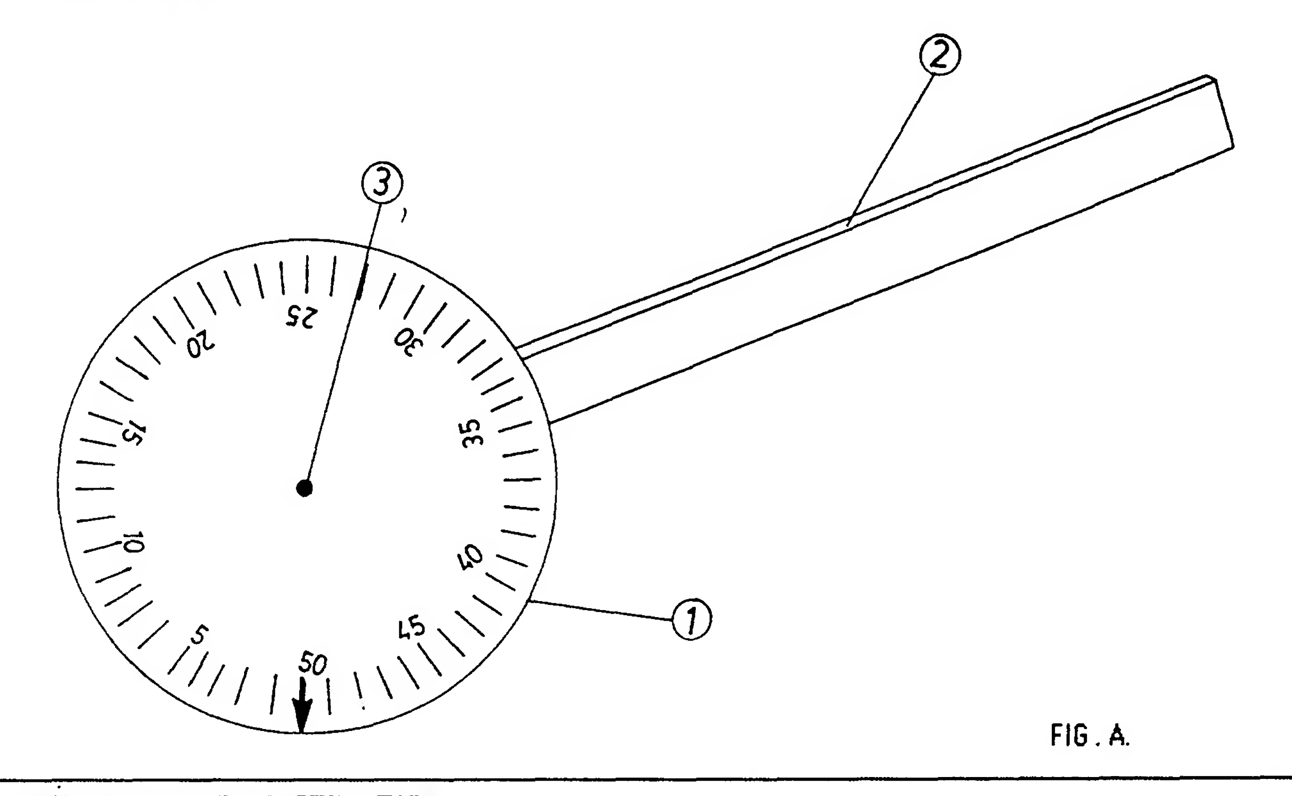


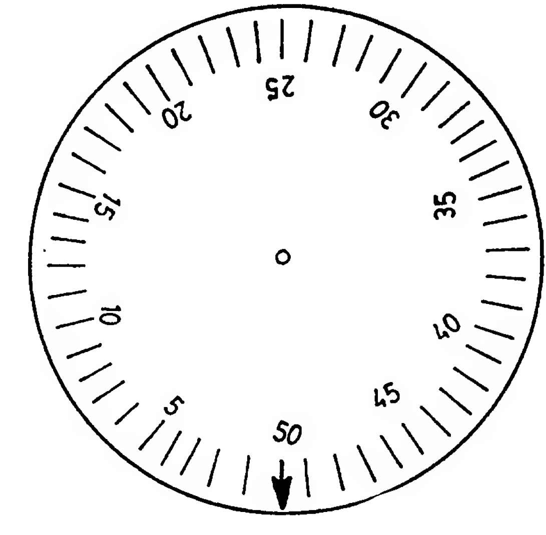
FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Disc.	1.	Hardboard sheet.	200mm x 200mm.
2- Handle.	1.	Wood	400mm x 30mm x 15mm
3- Axle.	1.	Split paper fastener	
	1.	Sheet of white paper	200mm x 200mm.

Tools; Woodsaw; compass; scissors; marker.

6- CONSTRUCTION DETAILS



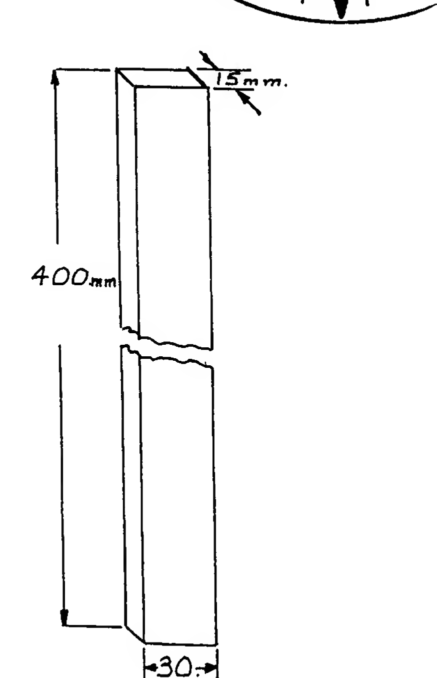


Fig. 1.

With the help of a compass mark a circle of dia 15.91 cms on the hardboard sheet. Using the woodsaw accurately cut out this disc.

Using the compass mark out a disc of 15.91 cms on the piece of white paper and cut out this circle using the scissors. Paste this circle onto the hardboard disc.

To mark out the scale divide the white disc into 10 equal parts. Subdivide each part into 5 equal parts. This means that the circle has 50 equal divisions. Using a marker number the divisions as indicated in the sketch. Drill a small hole in the centre of the disc to take the split fastener.

Fig. 2.

Using the woodsaw cut a wooden handle of 400mm x 30mm x 15mm size. Smooth the handle using sandpaper. Drill a hole near one end to take the fastener, as indicated in Fig. 2.

To assemble, push the fastener through the hole in the disc and then through the hole in the handle. Bend the end of the fastener to hold the disc in place but just loose enough for the disc to be free to rotate.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$ 1.00.

8- METHOD OF USE

Put the wheel on the ground in such a way that the arrow (50 mark) is the starting point. Push the wheel in the forward direction. It will travel a distance equal to half a metre when the starting mark has completed one revolution.

9- COMMENTS

1- ITEM

SIMPLE GAS GENERATOR.

2- PURPOSE

For generating small quantities of gas for use in chemistry experiments.

3- INFORMATION SUBMITTED BY

School Science Equipment Develpment Project,
National Institute of Science and Technology, Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

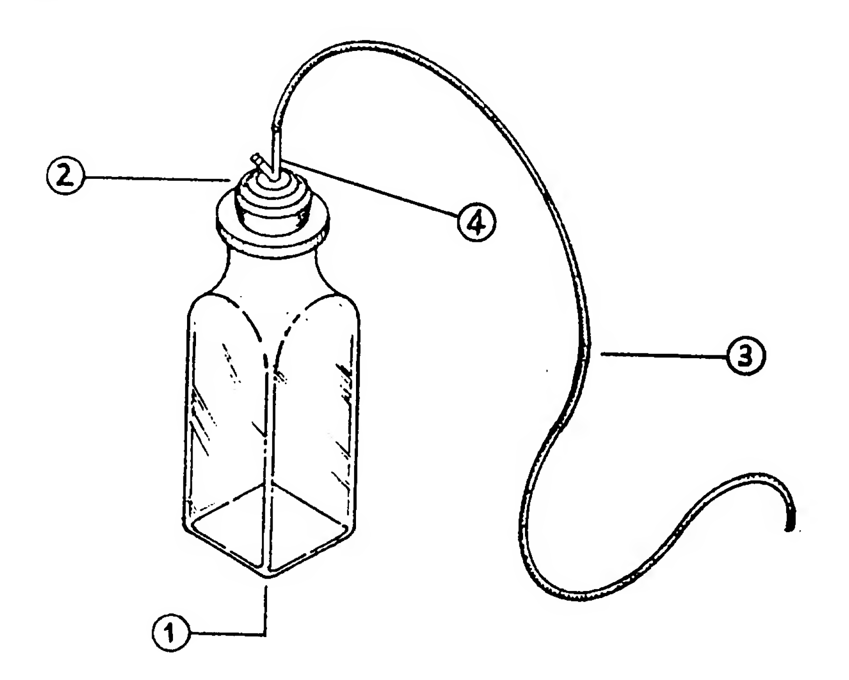


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Glass jar.	1.	Glass bottle, small, wide mouthed.	---
2 - Stopper.	1.	Rubber foot (for stool) or door stop, or one-holed rubber stopper.	Size to fit wide mouthed bottle.
3 - Gas Delivery tube.	1.	Flexible plastic tubing.	Diameter to suit connector x 50cm long.
4 - Connector.	1.	Rigid plastic tubing.	As available, approx. 4 to 6mm outside dia.

6- CONSTRUCTION DETAILS

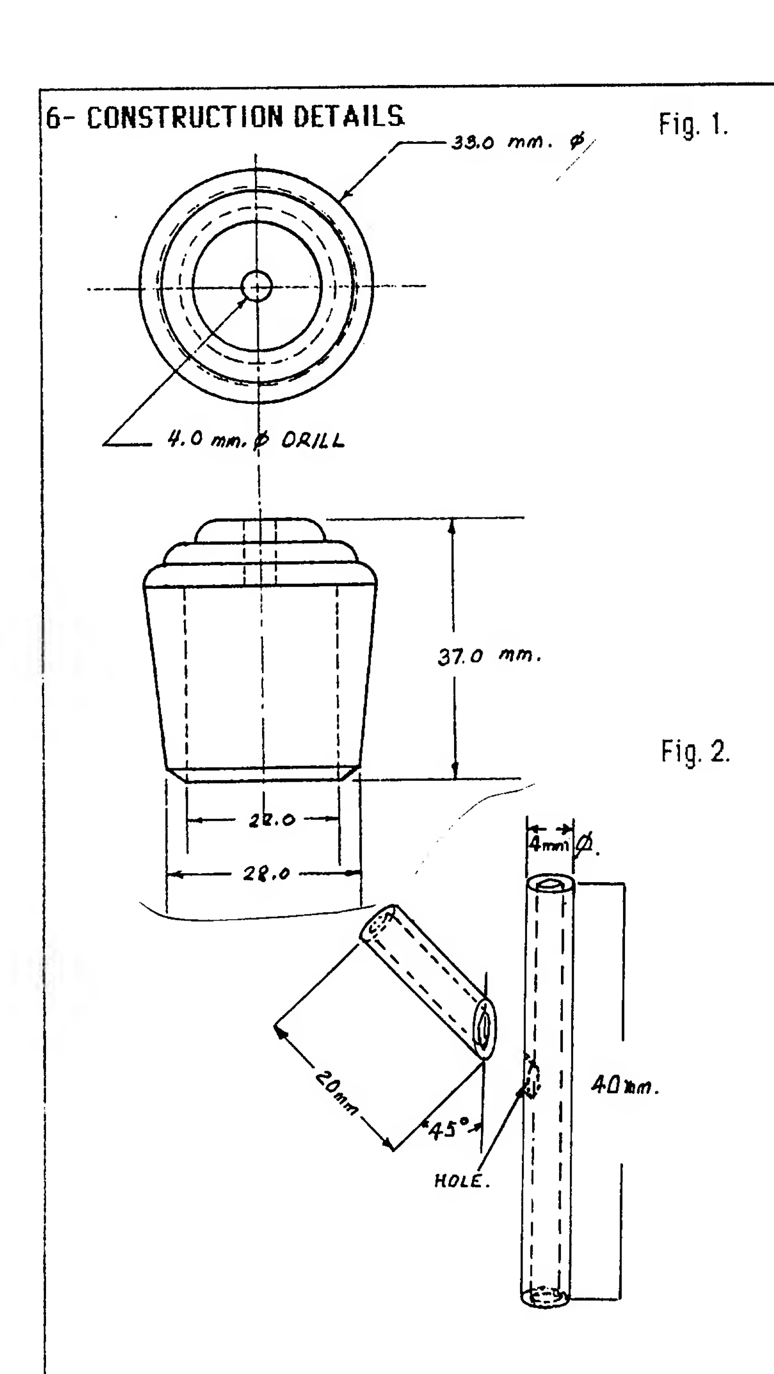


Fig. 1. Drill a 4mm hole in the rubber foot as indicated.
Note: the actual size of the hole to be drilled will depend upon the size of the plastic tubing used for the connector.

Fig. 2. If the plastic or glass 'Y' piece is not available construct a connector as follows. Take a piece of rigid plastic tubing of approx. 6cm length and cut a 2cm length from it. File one end to an angle of 45° and, using a small round file, concave the end to fit the vertical tube. Drill a hole in the side of the vertical tube the same diameter as the bore of the tube. Using a suitable adhesive fix the side arm to the vertical tube. Finally ensure that all airways are not blocked with adhesive.

To assemble insert the 'Y' piece into the stopper. Attach the flexible delivery tube to the vertical arm of the connector. The stopper is then ready for insertion in the mouth of the glass bottle.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50.

8- METHOD OF USE

Solid material can be placed inside the bottle and liquid reagent introduced by means of a syringe or dropper to produce the desired gas. The side arm should then be closed and the generated gas collected via the delivery tube, in an inverted test tube immersed in water.

9- COMMENTS

1- ITEM

FIRE EXTINGUISHER.

2- PURPOSE

To demonstrate the principle and function of a fire extinguisher.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids
National Educational Equipment Centre. Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

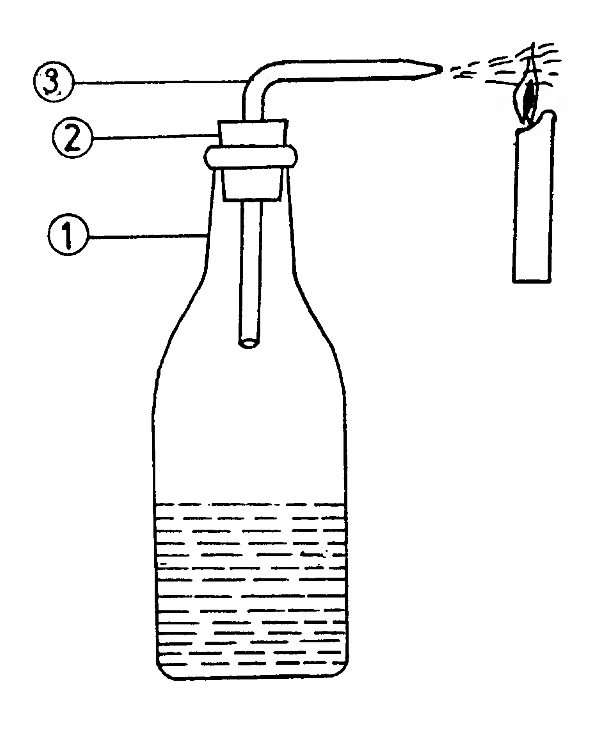


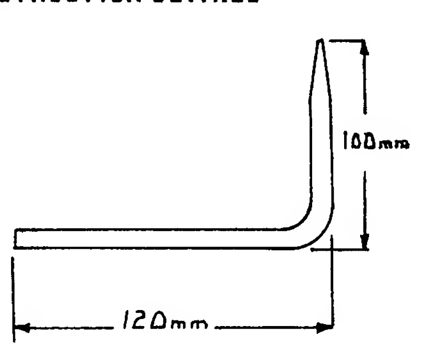
FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Container.	1.	Glass bottle.	
2 - Stopper.	1.	Rubber stopper.	to fit bottle.
3 - Jet.	1.	Glass tubing.	5mm dia x220mm long.
		Candle.	
		Cork borer.	5mm dia.
		Vinegar.	
		Baking powder.	
		Spirit lamp.	

6- CONSTRUCTION DETAILS

Fig. 1



Take a piece of glass tubing of 5mm dia and draw out a jet. Bend the glass tubing according to the size indicated in the sketch.

With the help of the cork borer make a 5mm dia hole in the rubber stopper. Insert the glass tubing jet into the stopper, and insert the stopper into the bottle.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.00.

8- METHOD OF USE

Remove the stopper and jet tube from the bottle. Pour some vinegar and baking powder into the bottle and quickly replace the stopper and tube. Light a candle and bring it near the jet. The candle will be extinguished due to the carbon dioxide coming out of the jet due to the reaction between the vinegar and baking powder

9- COMMENTS

Practice will be necessary to achieve the desired result with the glassworking.

1- ITEM

MOLECULAR MODEL OF CO_2.

2- PURPOSE

To demonstrate the structure of a CO_2 molecule.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids.
National Educational Equipment Centre. Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

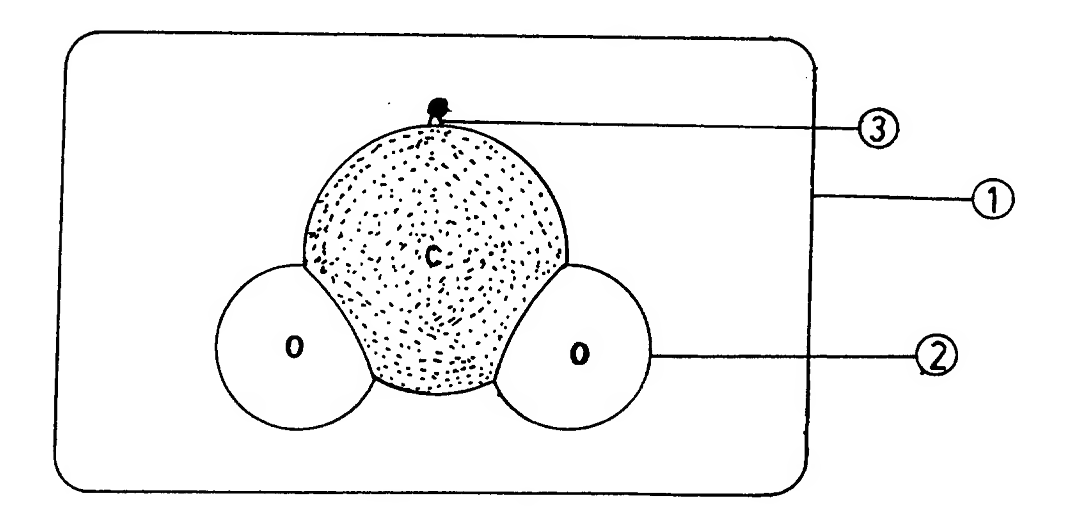


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Baseboard.	1.	Cardboard.	300mm x 200mm.
2 - Model.	1.	Styrofoam.	
3 - Hook..	1.	Steel wire.	20 gauge x 30mm.
		Black marker.	
		Drawing pins.	

Tools: knife; file.

6- CONSTRUCTION DETAILS

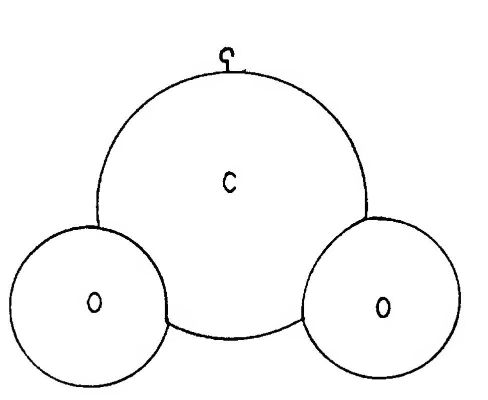
Fig. 1.

200mm

300 mm

Prepare the baseboard by cutting a piece of stiff cardboard (or hardboard) to the sizes indicated in the sketch.

Fig. 2.



Cut three pieces of styrofoam of 50mm thickness to make three circular balls i.e. one of 50mm dia to represent the carbon atom, and two of 20mm dia to represent the oxygen atoms.

Using a black marker pen colour the carbon atom black. Leave the two oxygen atoms white. File two flat surfaces on the carbon atom and one each on the oxygen atoms so that they can be firmly glued together in the positions shown in the sketch. Then glue them together. This forms the CO_2 molecule.

Using the steel wire make a hook and fix it to the model which can then be hung onto the baseboard using a drawing pin.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50.

8- METHOD OF USE

The model of the CO_2 molecule can be displayed as indicated in Fig. A. Other molecular models, such as H_2O, can also be prepared and demonstrated in this manner.

9- COMMENTS

1- ITEM

ENVIRONMENTAL GAME.

2- PURPOSE

To teach the concept of position and classification to Grades 1 and 2.

3- INFORMATION SUBMITTED BY

The Institute for the Promotion of Teaching Science and Technology (IPST), Bangkok, Thailand.

4- LINE DRAWING OF PROTOTYPE

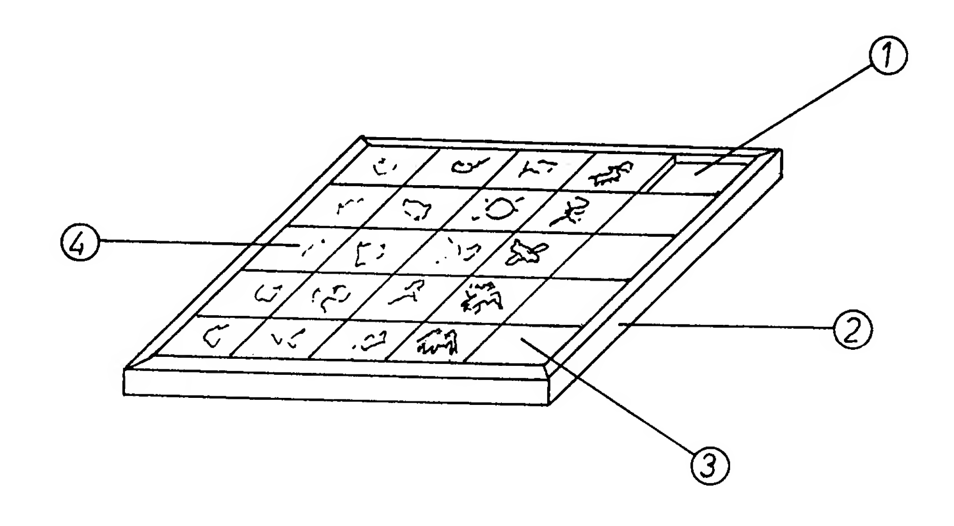


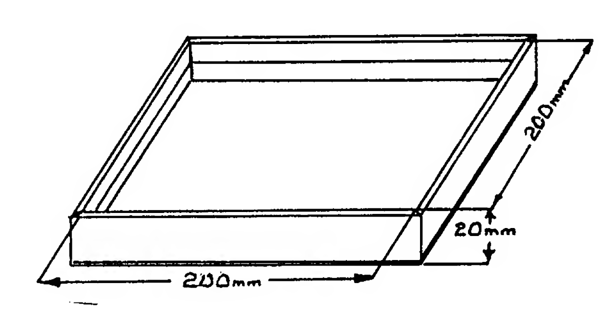
FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Base.	1.	Plywood.	220mm x 220mm x 10mm.
2 - Frame.	1.	Plywood. strips.	240mm x 20mm x 10mm.
3 - Squares.	24	Plywood.	40mm x 40mm x 10mm.
4 - Pictures.	20	Paper.	40mm x 40mm.

6- CONSTRUCTION DETAILS

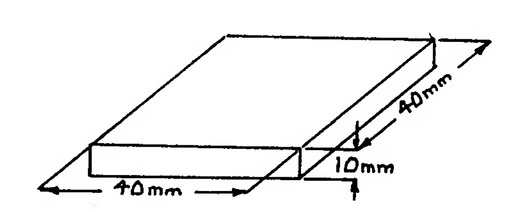
Fig. 1.



Prepare a piece of plywood (or other suitable material) to a size of 220mm x 220mm.

From the same material (10mm thick) cut strips of approx. 220mm x 10mm to form the sides of the tray. Mitre the corners and, using glue and nails, fix the sides onto the base.

Fig. 2.



Using the same material as the base cut 24 squares of size 40cm x 40cm (the actual size should be such that when the squares are located in the tray they can easily be moved around or taken out).

Leave four squares blank and on the remaining 20 stick pictures of pupils, animals, plants, birds, etc.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50.

8- METHOD OF USE

The teacher would give the pupils an opportunity to carry out an activity in grouping similar things together. For example, the pupils may be expected to group similar items in rows, or as an alternative, a square with a pupil marked on it is located in the middle and birds, for example, in one corner, four legged animals in another, and so on.

9- COMMENTS

1- ITEM

SIMPLE BALANCE.

2- PURPOSE

For Balancing Weights.

3- INFORMATION SUBMITTED BY

Science Equipment Centre, Lagos, Nigeria.

4- LINE DRAWING OF PROTOTYPE

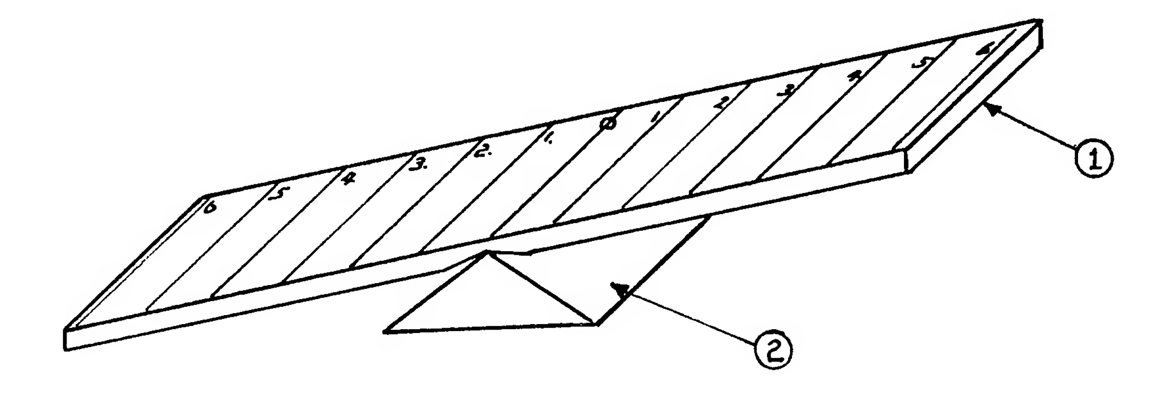


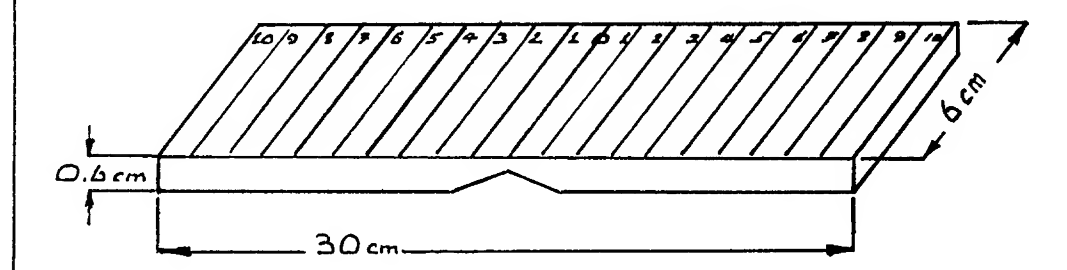
FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Tray.	1.	Plywood.	30cm x 6cm x 0.6cm
2- Stand.	1.	Wood.	5cm x 5cm x 2.0cm

6- CONSTRUCTION DETAILS

Fig.1.



Cut a piece of plywood to the sizes indicated. Mark out equal divisions on one face,starting from the centre. Such divisions serves as a guide when balancing and weighing objects. On the reverse face cut a "V" shaped notch at the centre line.

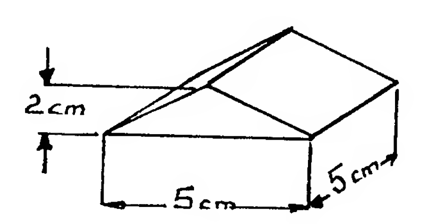


Fig. 2. Using a piece of hard wood such as mahogany or Iroko construct the triangular-shaped stand as indicated in Fig.2.

Place the tray on the stand and ensure that the tray swings freely on the stand and settles horizontally. Adjust as necessary, either by removing shavings of wood from the heavier underside of the tray or adding plasticine to the underside of the lighter side.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$ 4.50.

8- METHOD OF USE

Place objects on one side and balance using masses on the other side.

9- COMMENTS

1- ITEM

SIMPLE MOMENT BALANCE.

2- PURPOSE

Principle of Moments with respect to position of weights

3- INFORMATION SUBMITTED BY

National Workshop for Production of Low Cost Teaching Aids.
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

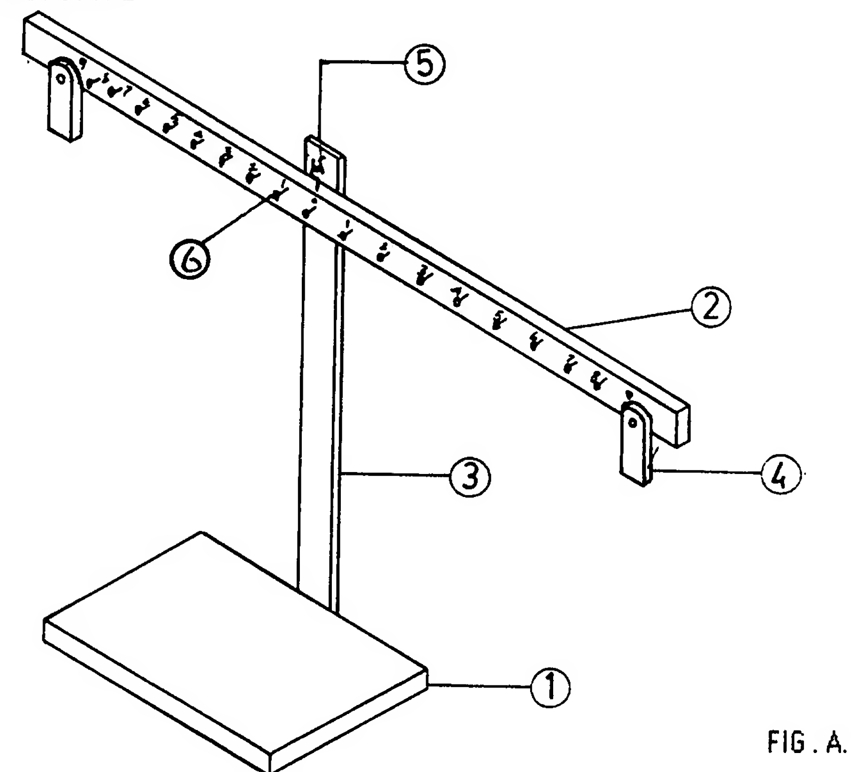


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Base.	1.	Wood.	150 x 100 x 10mm.
2- Balance Arm.	1.	Wood.	400 x 50 x 10mm.
3- Vertical Support.	1.	Wood.	300 x 20 x 5mm.
4- Weights.	8.	Hardboard.	50 x 20 x 5mm.
5- Hooks.	2.	Metal.	---
6- Nails.	25.	Metal.	---

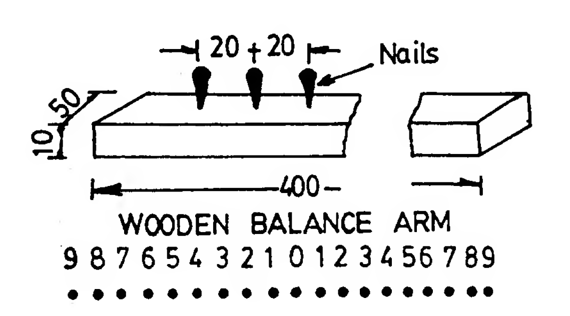
Tools: Woodsaw; Hammer;
Hole punch 10mm dia.

6- CONSTRUCTION DETAILS

Fig.1. Cut the wooden base of 150 x 100 x 10mm as shown, with the help of the woodsaw.

100
10
150
WOODEN BASE

Fig.2. Cut the wooden balance arm of size 400 x 50 x 10mm and fix 19 nails equally spaced at 20mm distance as shown at 2.a. with the help of the woodsaw and hammer.

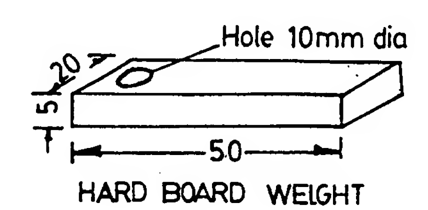


2a.

Fig.3. Cut the vertical wooden support bar of size 300 x 20 x 5mm with the help of the woodsaw.

20
5
300
WOODEN VERTICAL BAR.

Fig.4. Cut hardboard weights of 50 x 20 x 5mm size and punch the holes of 10mm dia at one end, with the help of the woodsaw, hole punch and hammer.



Fix a hook at one end of the vertical bar and fix this bar to the wooden base at the middle of the 150mm side vertically, with the help of nails and hammer.

Fix a hook at the middle of the balancing arm and hang it from the hook of the vertical support bar as shown in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$ 1.00.

8- METHOD OF USE

Balance the arm with the help of hanging weights. It is observed that the balancing arm is balanced when the product of moment arm and weights on each side are equal.

9- COMMENTS

1- ITEM

ELEMENTARY BALANCE.

2- PURPOSE

Used for weighing objects.

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project,
National Institute of Science and Technology, Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

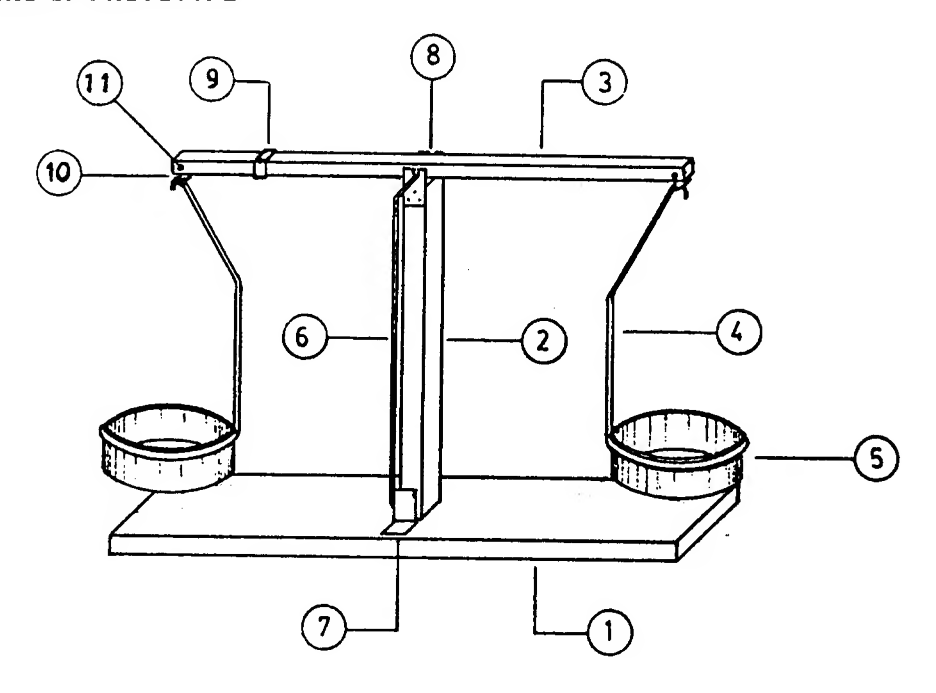


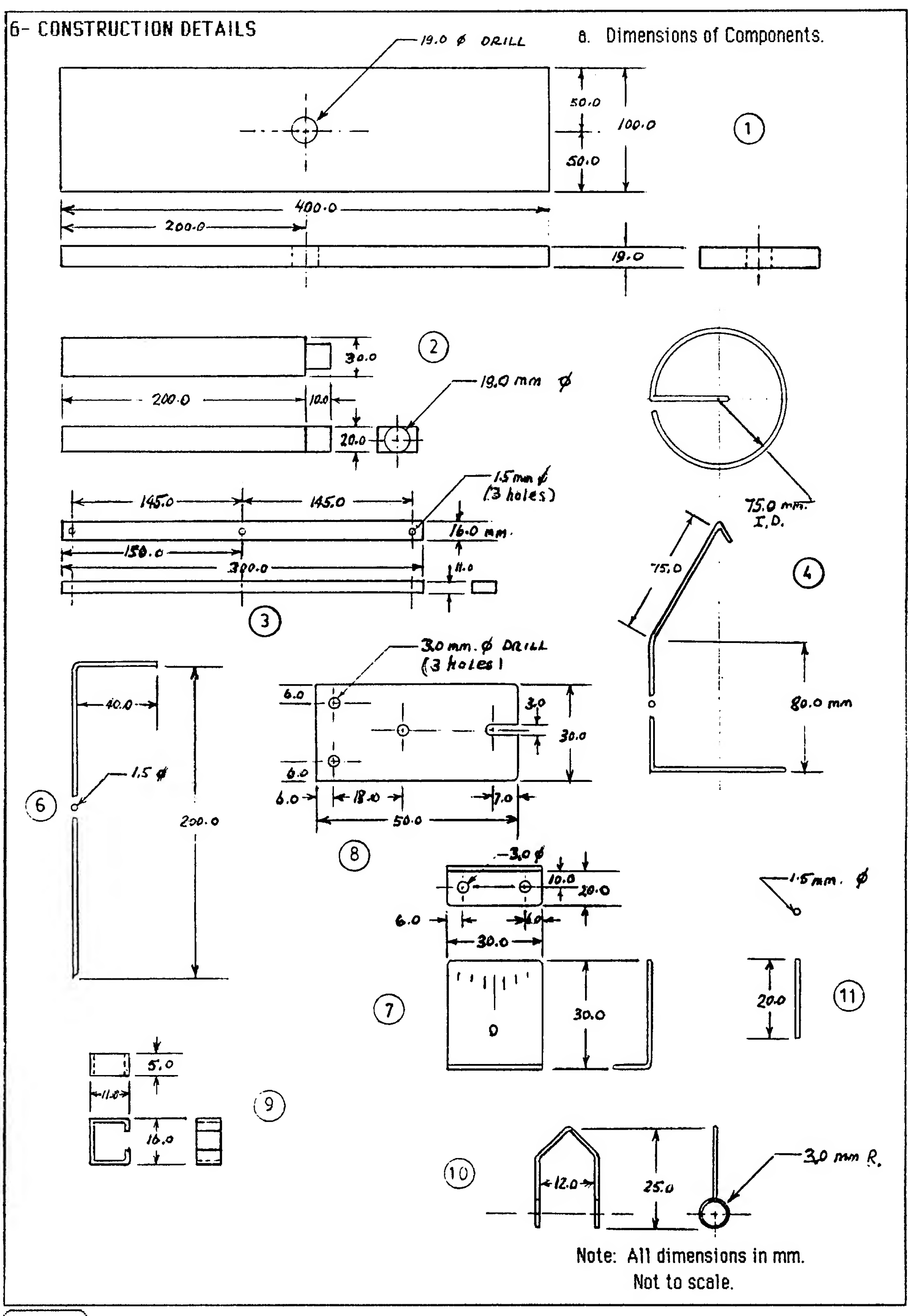
Fig. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Base.	1.	Plywood.	400mm x 100mm x 19mm.
2 - Stand.	1	Wood.	210mm x 30mm x 20mm.
3 - Balance Arm.	1.	Wood.	300mm x 16mm x 11mm.
4 - Pan support/hanger.	2.	Galvanised iron wire.	approx. 720mm x 12 gauge.
5 - Pan.	2.	Plastic glass-jar cover.	approx.75mm dia x 18mm deep.
6 - Pivot/pointer.	1.	Steel wire.	1.5mm dia. x 240mm long.
7 - Scale.	1.	Aluminium sheet.	50mm x 30mm x 18 gauge.
8 - Pivot rest.	2	Mild steel sheet.	50mm x 30mm x 18 gauge.
9 - Rider.	1.	Mild steel sheet.	50mm x 30mm x 18 gauge.
10 - Pan Hanger.	2.	Steel wire.	1.5mm dia. x 120mm approx.
11 - Pan hanger pivot.	2.	Steel wire.	1.5mm dia. x 20mm long.

6- CONSTRUCTION DETAILS

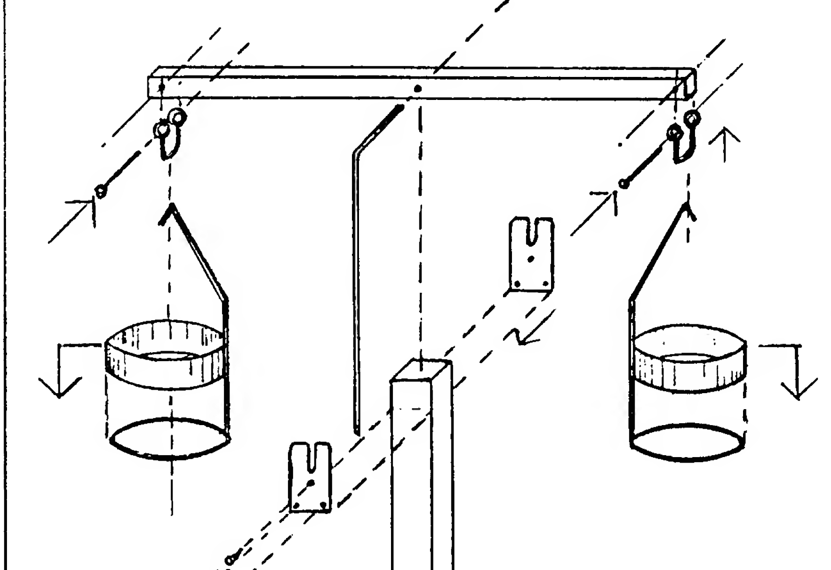
a. Dimensions of Components.



Note: All dimensions in mm.
Not to scale.

6- CONSTRUCTION DETAILS (Continued)

b. Assembly drawing.



Cut, drill holes and finish (with sandpaper) the wooden components.

Form the metal sheets into the pivot rest, rider, and scale.

Bend the steel wires for the pivot/pointer and the pan hanger into their required shapes. A nail may be used for forming the eyes of the pan hangers.

For the pan support wrap the galvanised iron wire around the plastic cap to form a circle (screwing the cap on its bottle will help to make it rigid). Remove the wire from the cap and tighten the circle by hand or with pliers until the cap fits snugly into it. Draw a line drawing of the shape of the pan support on a piece of cardboard and, using this as a guide bend the wire into its final shape.

Assemble the components as shown in the assembly drawing. Mount the pointer so that it is perpendicular to the balance arm.

7- APPROXIMATE COST OF ONE ITEM (in US $)

$12.00.

8- METHOD OF USE

Weighing by balancing an unknown mass against standard masses (weights).

9- COMMENTS

In the construction of the balance arm, care must be taken in drilling the three holes. The holes on both ends of the arm must be accurately drilled equidistant from the centre hole. The steel pivots must also fit snugly into the holes of the balance arm so that rotation occurs between metal parts rather than the pivot and the wooden arm.

1- ITEM

TWO PAN BALANCE.

2- PURPOSE

Comparing the mass of two bodies.

3- INFORMATION SUBMITTED BY

FUNBEC, Brazil.

4- LINE DRAWING OF PROTOTYPE

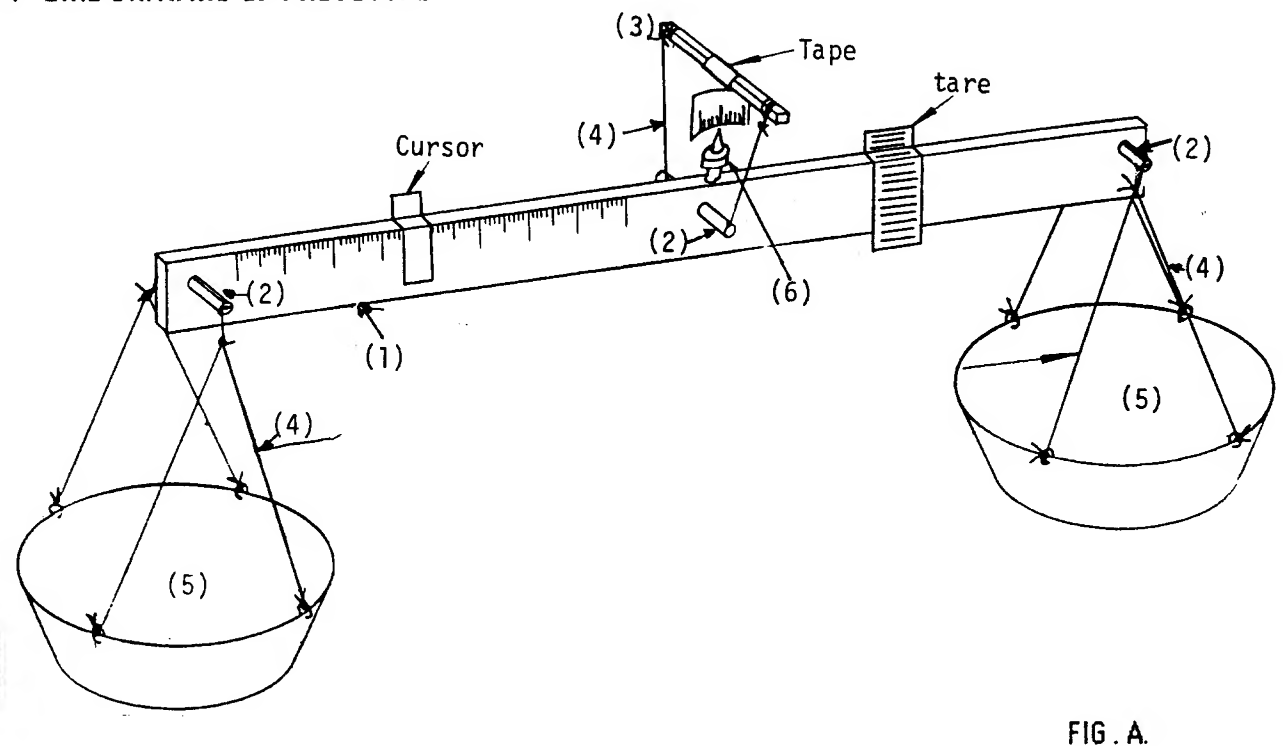


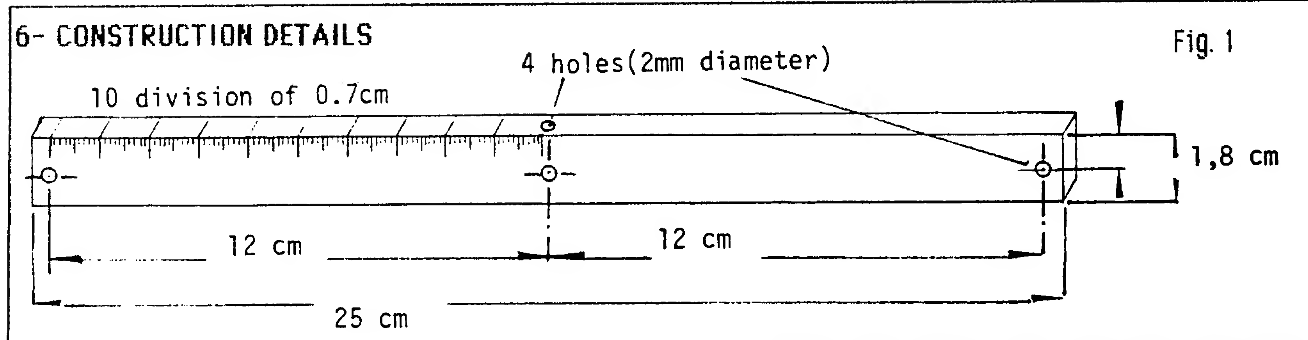
FIG. A.

5- MATERIALS FOR CONSTRUCTION

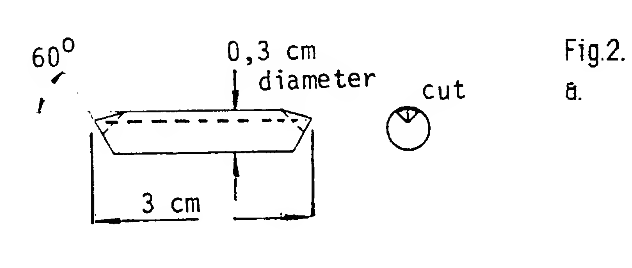
Components	Qty	Materials Required	Dimensions
1 - Beam.	1.	Wood.	25cm x 1.8cm x 0.5cm
2 - Pan and beam supports.	3.	Wood bolts. (or dowels).	2mm dia. x 30mm long.
3 - Holder.	1.	Any hard material.	0.5 x0.5cm x 15cm long.
4 - Suspension.		Nylon thread	1.5m long.
5 - Pans.	2.	Plastic or aluminium.	8cm dia x 2cm depth.
6 - Sensitivity Regulator	1.	Copper wire.	0.2 cm dia x 3cm long.
Cursor and Tare.	2.	Aluminium Foil.	0.01cm x 3cm x 5cm.

6- CONSTRUCTION DETAILS

Fig. 1



Prepare the beam to the dimensions given and drill the holes as accurately as possible. Carefully mark the scale using the dimensions given.



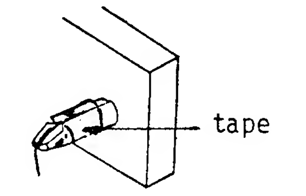


Fig.2.

a. Cut the slots in the 3 bolts and file the angled ends. Screw the bolts through the holes in the beam leaving the end ones with their slots upwards and the centre one with the slot downwards. Pass a piece of thread through the slots of each bolt and tape it in position

b. (Fig. 2.b.) leaving about 10cm hanging down at each end of the bolt.

Make a pointer approx. 8cm long using a toothpick and push it into the top hole vertical to the beam.
Wind the copper wire into a coil of 2mm internal diameter and push it onto the pointer.
Assemble the balance as indicated in Fig. A.
Balance the beam using the sensitivity regulator and the cursor (when making the cursor the piece of aluminium foil to be used should weigh 10mg)
Once the beam is suspended remove a little of the material from the left hand pan so that the beam hangs slightly down on the right hand side.
Place the cursor at the zero position and adjust the position of the tare for balance.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

Under $1.00

8- METHOD OF USE

Place an object in the pans and proceed as an elementary balance. The balance is used by suspending it from the holder. A paper scale fixed to the holder can be made if desired.

9- COMMENTS

Despite its simplicity this balance is sensitive enough to determine a mass of milligrams.

1- ITEM

SIMPLE MICROSCOPE.

2- PURPOSE

To show the principle and function of a simple students microscope.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids.
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

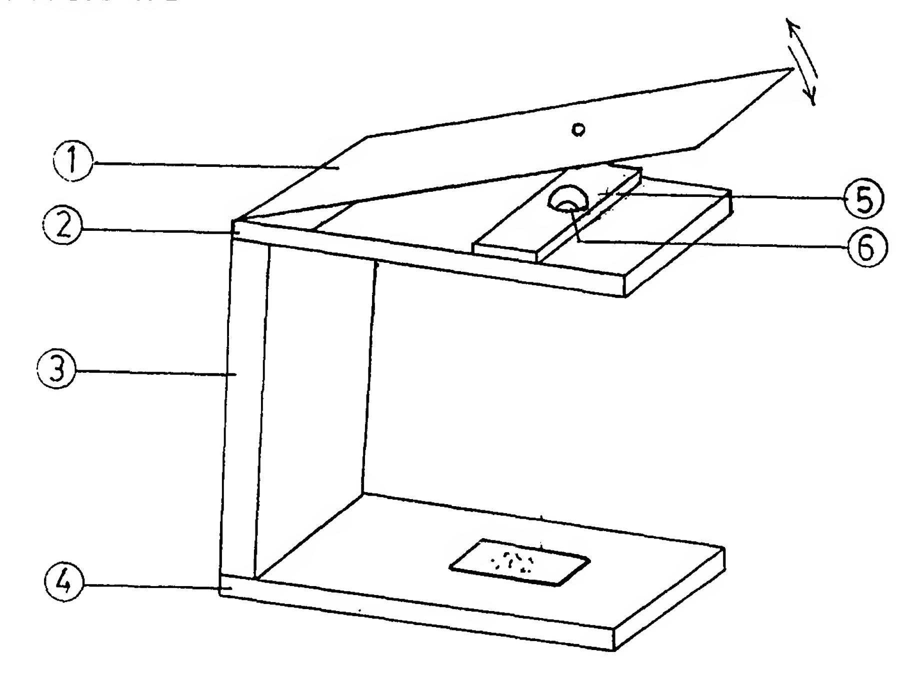


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Eyepiece.	1.	Tin strip.	80mm x 20mm.
2- Objective support.	1.	Wooden strip.	60mm x 20mm x 3mm.
3- Vertical support.	1.	Wooden strip.	50mm x 20mm x 5mm.
4- Base (stage).	1.	Wooden strip.	60mm x 20mm x 3mm.
5- Microscope slide.	1.	Glass microscope slide.	20mm x 15mm
6- Glycerine.		Glycerine.	
	6.	Nails.	

Tools. Wood saw; Hammer; Drilling machine; Tin snips; Pliers.

6- CONSTRUCTION DETAILS

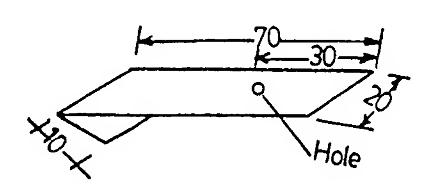


Fig.1. Using the tin snips cut a strip of tin sheet to the size 80mm x 20mm. Using the drilling machine drill a hole of 2mm dia as indicated. With the help of the pliers bend the strip at 10mm from the end furthest from the hole. This strip will act as the eyepiece for the microscope.

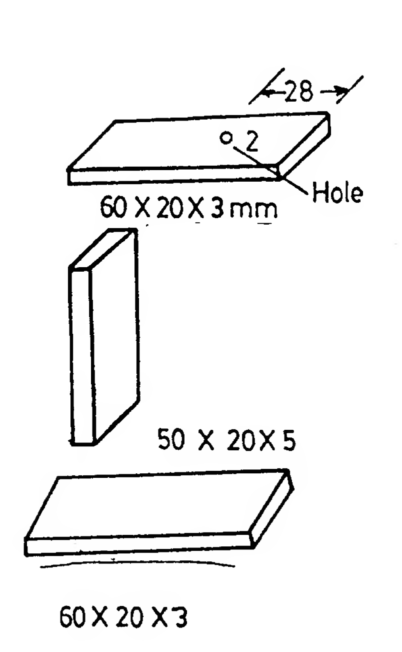


Fig.2.

a. Using the wood saw cut three wooden strips, two of 60mm x 20mm x 3mm, and one of 50mm x 20mm x 5mm, as shown at Fig.2.a,b,and c. In one of the 60mm x 20mm strips drill a 2mm dia hole.

b. This strip forms the vertical support for the eyepiece and objective.

c. This strip forms the base or stage on which the object to be viewed is placed.

Using the nails and hammer assemble the microscope as shown in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$ 1.00.

8- METHOD OF USE

Place a glass microscope slide above the hole in the objective support. Place a drop of glycerine on the slide above the hole. This will serve as the objective lens of the microscope. Place some small objects on the base (stage) of the microscope below the hole. View the objects through the hole in the tin strip. Focussing is carried out by lifting the tin strip upwards or pressing downwards as indicated by the arrows in Fig. A.

9- COMMENTS

This apparatus can be used to demonstrate the function of a simple microscope.

1- ITEM

GLASS BEAD MICROSCOPE.

2- PURPOSE

For viewing tiny specimens in the laboratory and for learning the basic parts of standard microscope.

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project,
National Institute of Science and Technology, Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

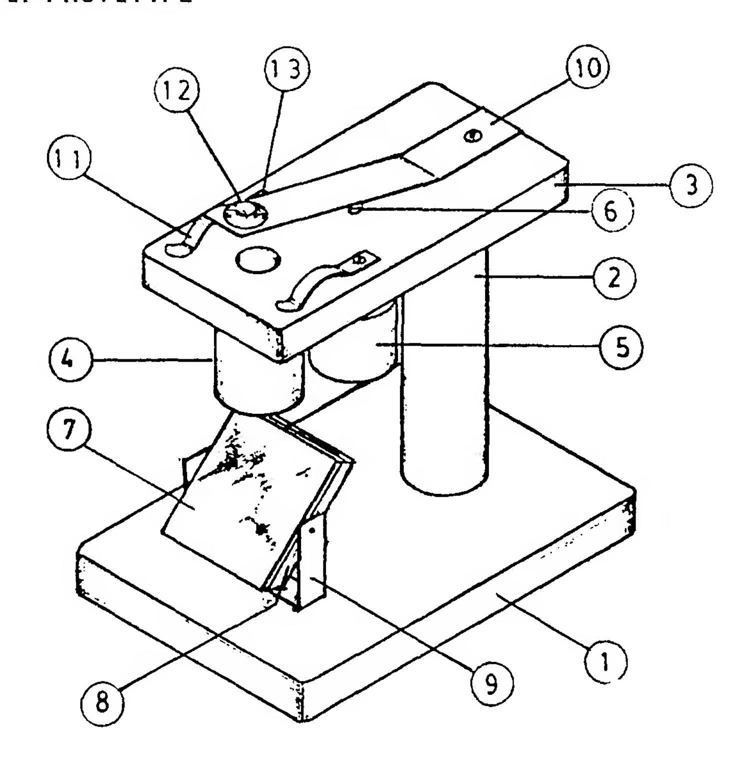
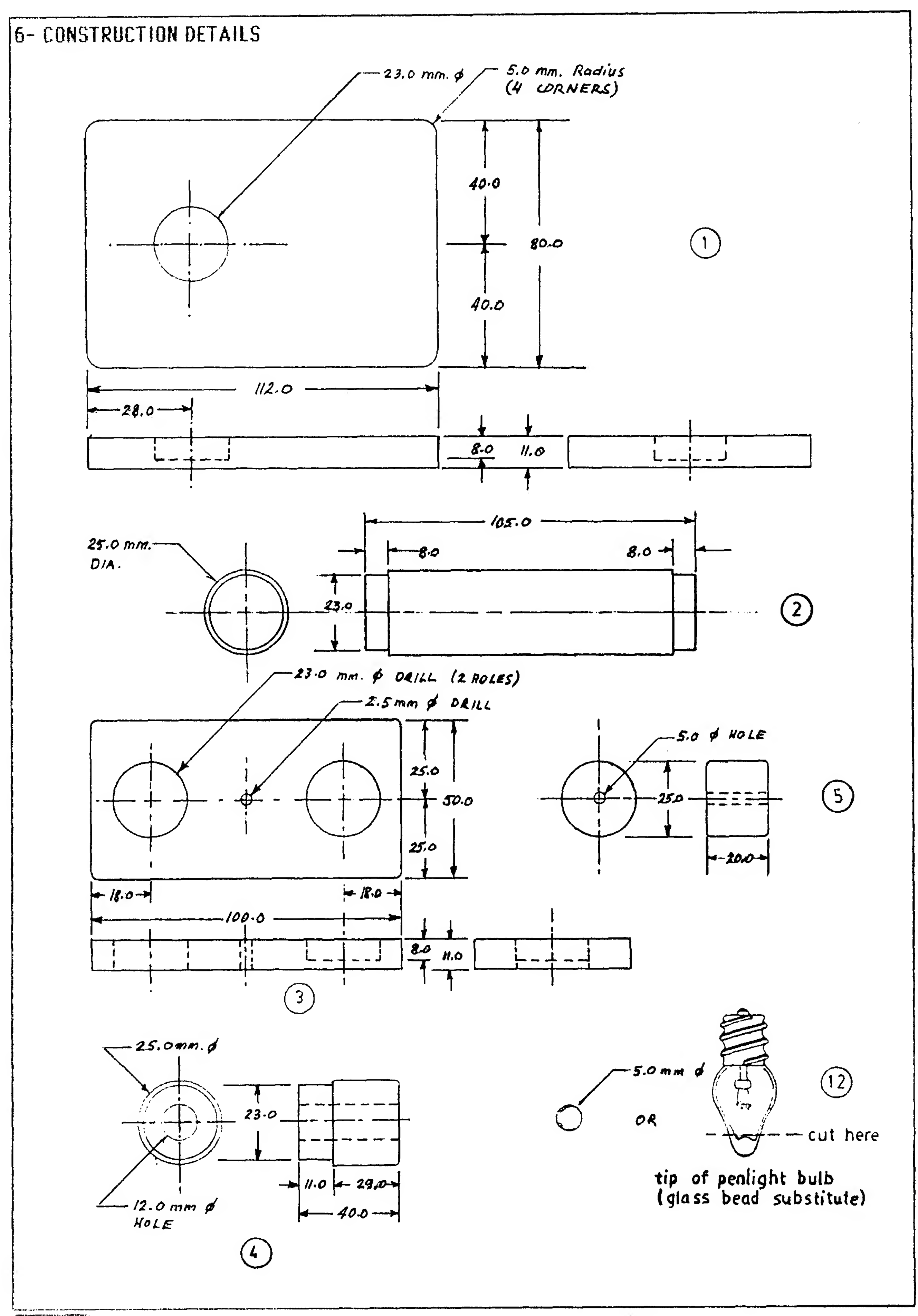


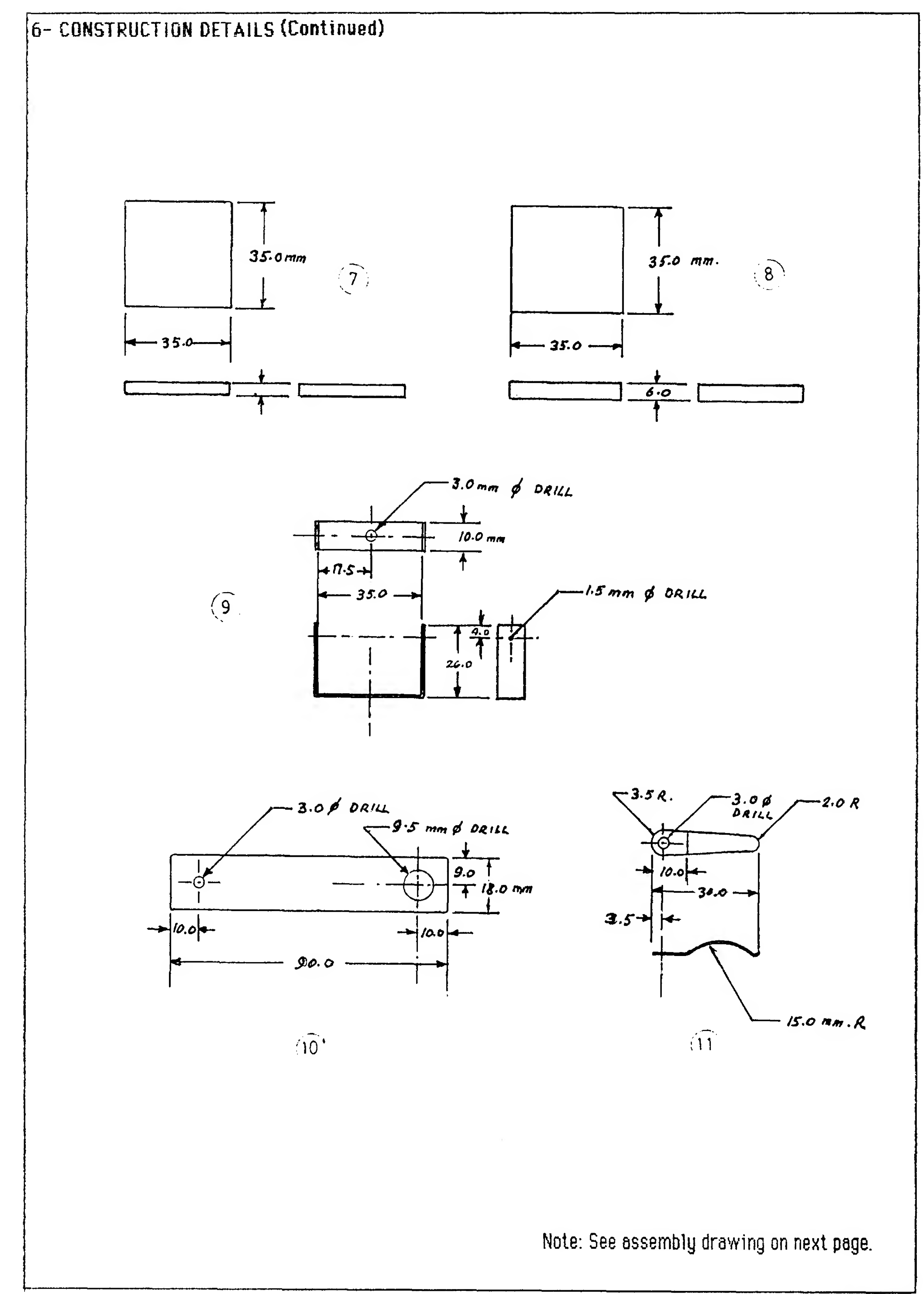
Fig. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Base.	1.	Plywood.	11mm x 80mm x 112mm.
2 - Stand.	1.	Wood.	25mm Ø x 105mm.
3 - Stage.	1.	Plywood.	11mm x 50mm x 100mm.
4 - Tube.	1.	Wood.	12mm I.D. X 25mm O.D.x40mm.
5 - Focus adjusting knob.	1.	Wood.	25mm Ø x 20mm.
6 - Adjusting screw.	1.	Stove volt.	5mm Ø x 38mm.
7 - Mirror.	1.	Mirror.	35mm x 35mm.
8 - Mirror support.	1.	Plywood.	6mm x 35mm x 35mm.
9 - Mirror clip.	1.	Crate band strip.	10mm x 87mm.
10 - Lens support strip.	1.	Crate band strip.	18mm x 90mm.
11 - Stage clip.	2	Crate band strip.	5mm x 30mm.
12 - Lens.	1.	Glass bead.	5mm Ø
13 - Lens holder.	1.	Rubber grommet.	3/16" Ø hole.


6- CONSTRUCTION DETAILS
23.0 mm. ϕ
5.0 mm. Radius
(4 CORNERS)
40.0
80.0
40.0
1
112.0
28.0
8.0
11.0
25.0 mm.
DIA.
105.0
8.0
8.0
23.0
2
23.0 mm. ϕ DRILL (2 HOLES)
2.5 mm ϕ DRILL
25.0
50.0
25.0
18.0
18.0
100.0
8.0
11.0
3
5.0 ϕ HOLE
25.0
20.0
5
25.0 mm. ϕ
23.0
12.0 mm ϕ
HOLE
11.0
29.0
40.0
4
5.0 mm ϕ
OR
12
cut here
tip of penlight bulb
(glass bead substitute)

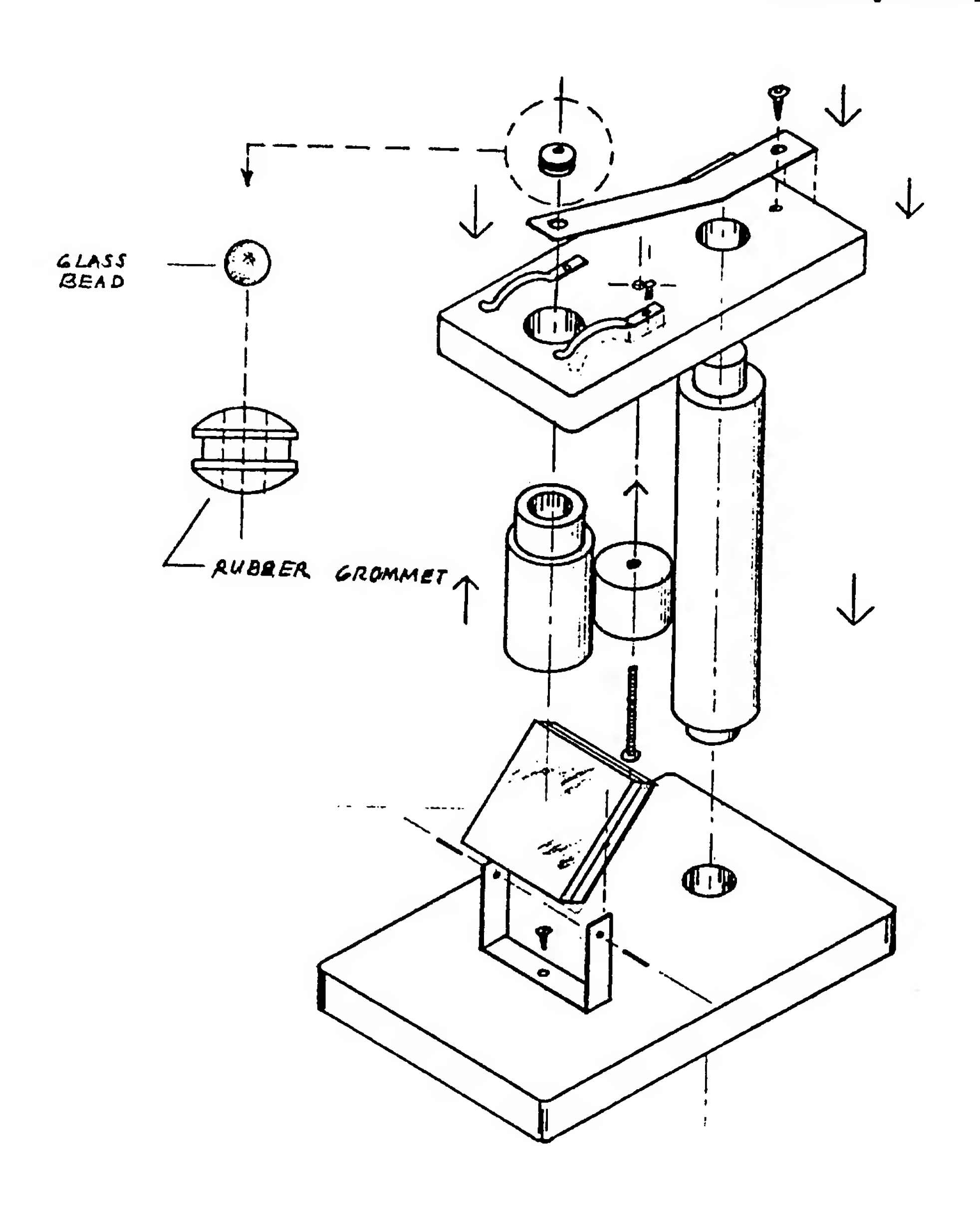
6- CONSTRUCTION DETAILS (Continued)



Note: See assembly drawing on next page.

6- CONSTRUCTION DETAILS (Continued)

Assembly drawing (Exploded view)



7- APPROXIMATE COST OF ONE ITEM (in US $)

$5.00.

8- METHOD OF USE

The specimen on the slide is held in place on the stage by the stage clip and focus is adjusted by the focus adjusting knob.

9- COMMENTS

Prepare the parts as shown in the detail construction drawing and assemble the apparatus as shown in the assembly drawing. Fix the parts with glue and screws.

A glassblower can fabricate the glass bead out of solid glass rod. The glass bead can be replaced with the lens tip of a pen light bulb. With the use of small triangular file and long nose plier, carefully cut off the tip of the pen light bulb.

1- ITEM

ARTIFICIAL LUNGS.

2- PURPOSE

To demonstrate the operation of the human lungs.

3- INFORMATION SUBMITTED BY

Institute for the Promotion of Teaching Science and Technology (IPST), Bangkok, Thailand.

4- LINE DRAWING OF PROTOTYPE

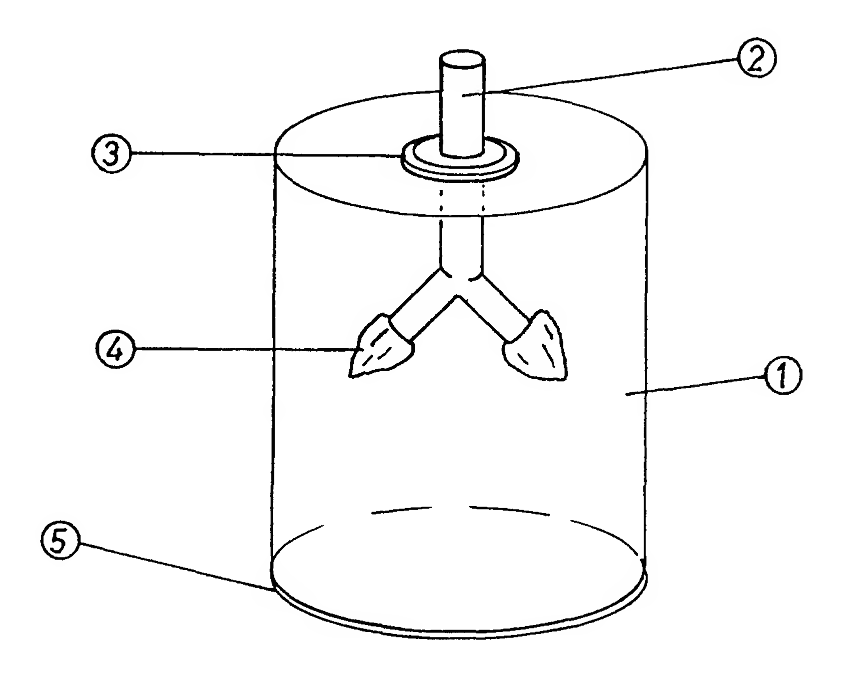


FIG . A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Container.	1.	Transparent plastic bottle.	as available.
2- Connector 'Y' piece.	1.	Ball point pen outer case.	-
3- Stopper.	1.	Rubber grommet (or stopper).	approx. 12mm dia.
4- Lungs.	2.	Small balloons.	
5- Diaphragm.	1	Rubber sheet (large balloon).	

6- CONSTRUCTION DETAILS

From a transparent plastic bottle cut off the top part. Using the bottom part of the bottle as the container, drill a 12mm dia hole centrally in the base.

Using the outer case from ball point pens construct a 'Y' piece as indicated in Fig A. Ensure that the joint is air tight. To each end of the arms of the 'Y' piece attach a small balloon.

Obtain a rubber grommet or stopper to fit into the hole in the base of the container. Make a hole in this rubber to take the longer stem of the 'Y' piece. Assemble the apparatus by inserting the 'Y' piece into the grommet and fixing this assembly into the base of the container.

Cover the open end of the container with a thin piece of rubber sheet (cut from a balloon) and fix this to the container using a rubber band, so as to make the container airtight.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50

8- METHOD OF USE

When the rubber sheet is pulled downwards the two small balloons will expand (inhale). When the sheet is pressed inwards the two balloons will deflate (exhale).
This activity indicates the operation of the human lungs.

9- COMMENTS

1- ITEM

WORKING MODEL OF LUNGS.

2- PURPOSE

To demonstrate the function of the lungs when inhaling and exhaling.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids.
National Educational Equipment Centre. Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

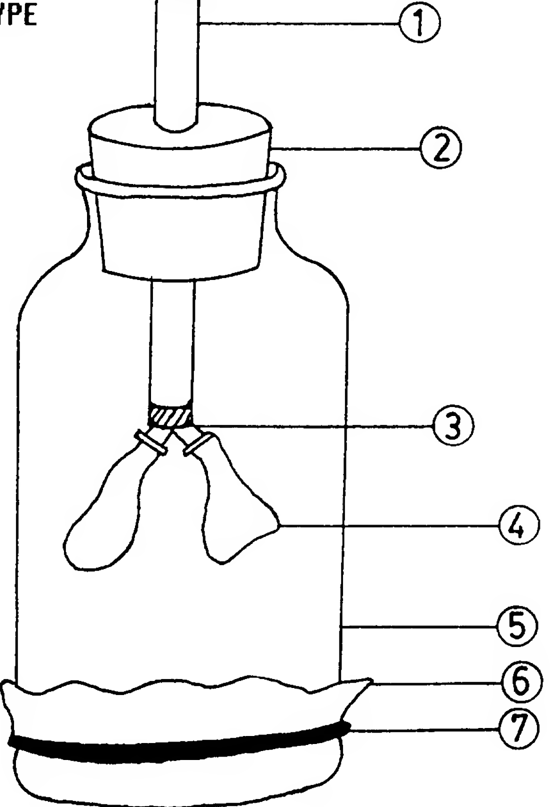


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Tube.	1.	Glass tubing.	6mm dia x 80mm long.
2- Stopper.	1.	Rubber (or cork) stopper.	To suit bottle.
3- Tubes.	2.	Plastic tubing (rigid).	3mm dia x 25mm long.
4- Lungs.	2.	Balloons.	
5- Container.	1.	Glass bottle.	
6- Diaphragm.	1.	Thin rubber sheet.	
	1.	Rubber band.	

Tools: Hammer; scotch tape; cork borer.

6- CONSTRUCTION DETAILS

SCORE LINE.

Fig. 1. Take the bottle and, using an old file or glass cutter, score a line around the bottle near the base. As neatly as possible break off the base (a red hot tip of metal placed on the score line may do this) and remove the sharp edges (using the old file or rubbing on concrete).

Fig. 2. Cut a piece of 6mm bore dia. glass tube to a length of 80mm. Prepare two plastic tubes of 3mm dia. and 25mm long, and insert them into the glass tube in such a way as to form a 'Y' piece. Using the scotch tape fix the tubes firmly in place and also ensure that the joint is air tight. Scotch tape two small balloons to the ends of the plastic tubes.

Note: Some bending/squashing of the ends of the plastic tubes may occur when fitting them into the glass tube. Ensure that the air way is not totally blocked.

To complete the assembly insert the tube into the stopper, having made a hole in the stopper to take the tube. Care will be needed in inserting the tube into the stopper particularly if the tube and 'Y' end will not pass through the neck of the bottle. Put the stopper assembly into the neck and then close the bottom end of the bottle with a thin piece of rubber (balloon) held in place with a rubber band as shown in Fig. A

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50.

8- METHOD OF USE

Using your fingers pull the diaphragm downwards and observe the balloons. Release the diaphragm and again observe the balloons. The balloons will have inflated and deflated and this acts like our lungs when we inhale and exhale.

9- COMMENTS

1- ITEM

AQUARIUM TANK.

2- PURPOSE

For keeping live fish or water plants

3- INFORMATION SUBMITTED BY

Science Equipment Centre, Lagos, Nigeria

4- LINE DRAWING OF PROTOTYPE

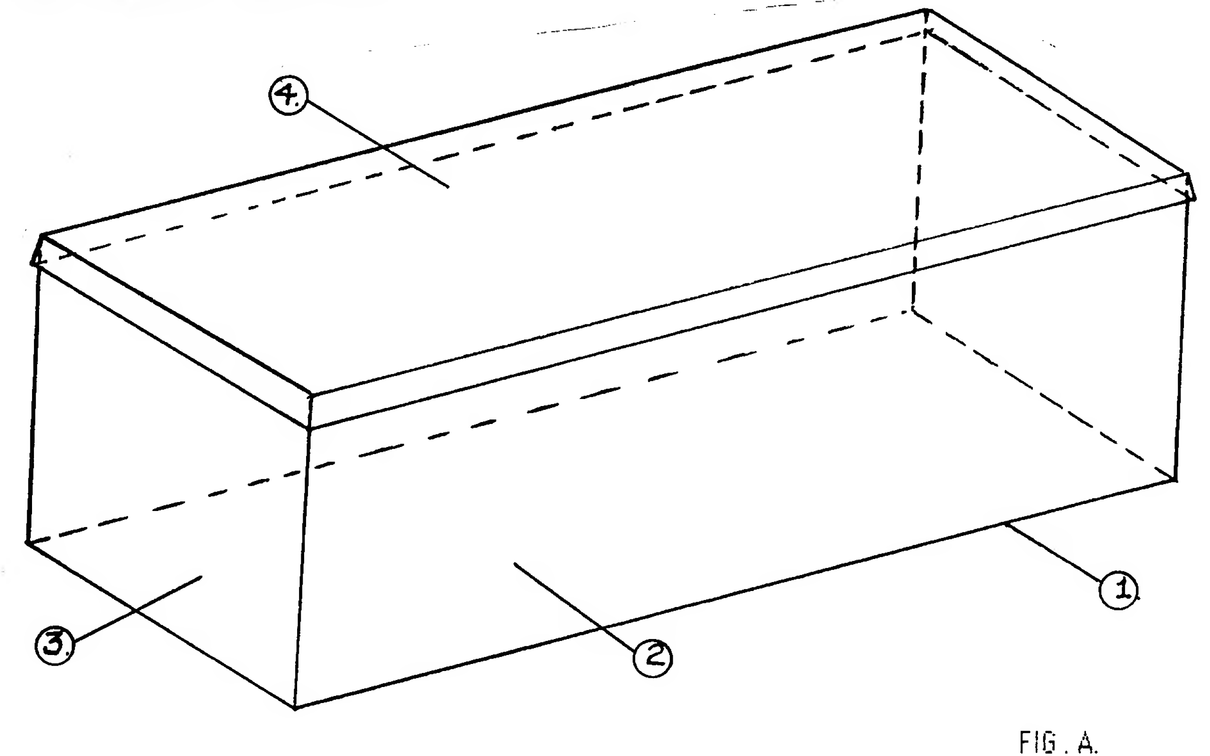


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Base.	1.	Acrylic/Perspex Sheet	80cm x 38.8cm.
2- Sides.	2.	" " "	80cm x 43.8cm.
3- Ends.	2.	" " "	43.8cm x 38.8cm.
4- Top.	1.	" " "	85cm x 44.5cm.

Tools. Saw; File:
Acrylic/Perpex Cement;
Clamps.

6- CONSTRUCTION DETAILS

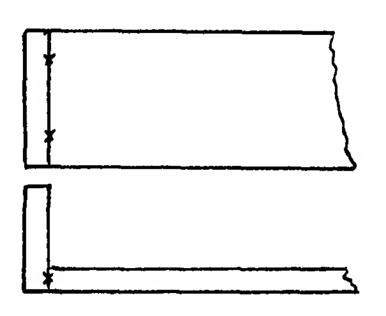


Fig. 1
Plan view

Side view

Cut the acrylic/perspex sheet to the required sizes.
Coat both ends of the base with the cement*and firmly clamp both end pieces to the base. Remove the clamps when the cement has set.

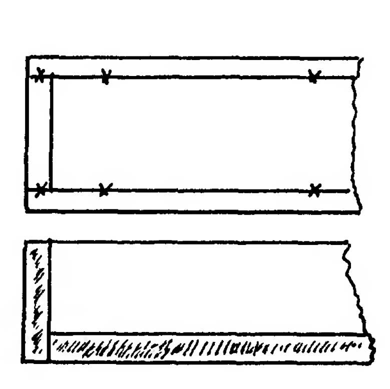


Fig. 2
Plan view

Side view

Coat both side edges of the base with the cement and both side edges of the end pieces. Clamp the side pieces to the base and end pieces. Remove the clamps when the cement has set.

Note: 'x' indicates surfaces to be coated with the cement.

Mark out the cover sheet to the size of the tank and cut the corners. Gently apply heat along the marked lines and when the sheet feels pliable evenly bend up the edges to approx. 90°**. (The cover size before bending should be approx. 5cm longer and wider than the tank size. This will allow for a 2.5cm bend all round).

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$60.00

8- METHOD OF USE

Locate the aquarium in the laboratory or classroom away from direct sunlight. Prepare the aquarium for effective display. Do not move the aquarium once it is full of water.

9- COMMENTS

*Acrylic/Perspex cement can be made by dissolving the acrylic/perspex filings in chloroform. Smear the plastic paste formed along the edges to be glued and apply pressure to the glued parts until the cement is dry.

**The bending of acrylic/perspex sheet is not easy particularly in the length indicated. A flat cover resting on small supports may be more suitable if the aquarium is constructed in a school.

1- ITEM

DISSECTING NEEDLE.

2- PURPOSE

For holding specimens during dissection.

3- INFORMATION SUBMITTED BY

Science Equipment Centre, Lagos, Nigeria

4- LINE DRAWING OF PROTOTYPE

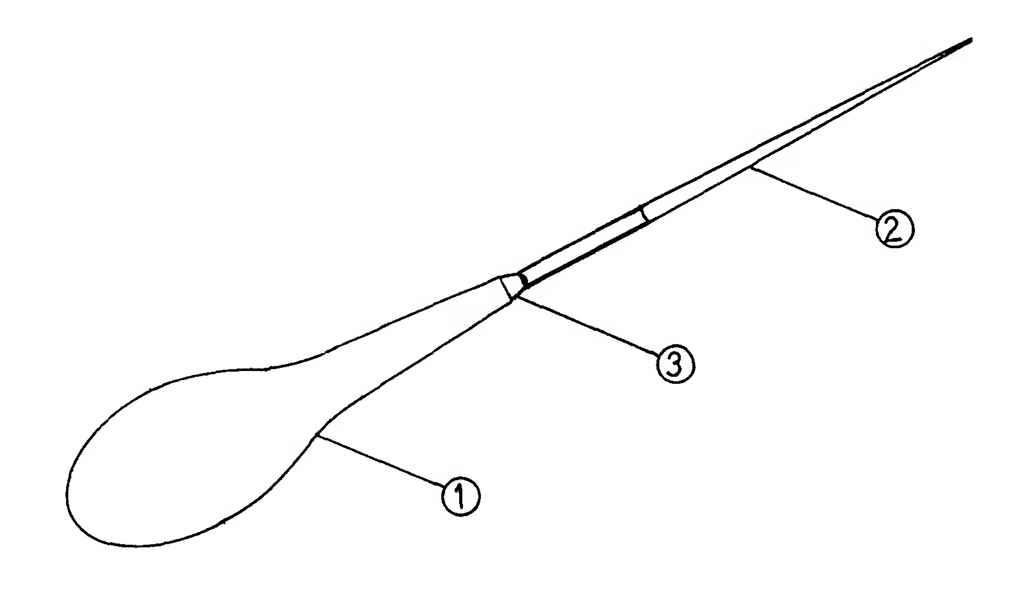


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Handle.	1.	Wood.	10cm x 2.5cm x 2.5cm.
2- Needle.	1.	Steel wire.	2mm dia x 10cm long.
3- End cap (ferrule).	1.	Sheet metal.	----

6- CONSTRUCTION DETAILS

Fig. 1.

Using a lathe turn the handle to shape from the piece of wood. Drill a hole, the same diameter as the needle, into the handle from the narrow end as indicated.
Using sandpaper finish the handle to a smooth finish.

Fig. 2.

Using a grinder grind a taper on a suitable length of the steel wire leaving a parallel shank to fit into the handle.

Fig. 3.

Using a piece of sheet metal construct an end cap to suit the end size of the handle. Drill a hole slightly smaller than the needle dia.

To assemble, carefully push the needle into the handle (this should be a tight fit). Finally fit the end cap in place by pushing it along the needle until it fits tightly in place.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$3.00.

8- METHOD OF USE

As required during dissection of specimens.

9- COMMENTS

1- ITEM

DISSECTING BOARD

2- PURPOSE

For dissecting small animals in the laboratory.

3- INFORMATION SUBMITTED BY

Science Equipment Centre. Lagos, Nigeria.

4- LINE DRAWING OF PROTOTYPE

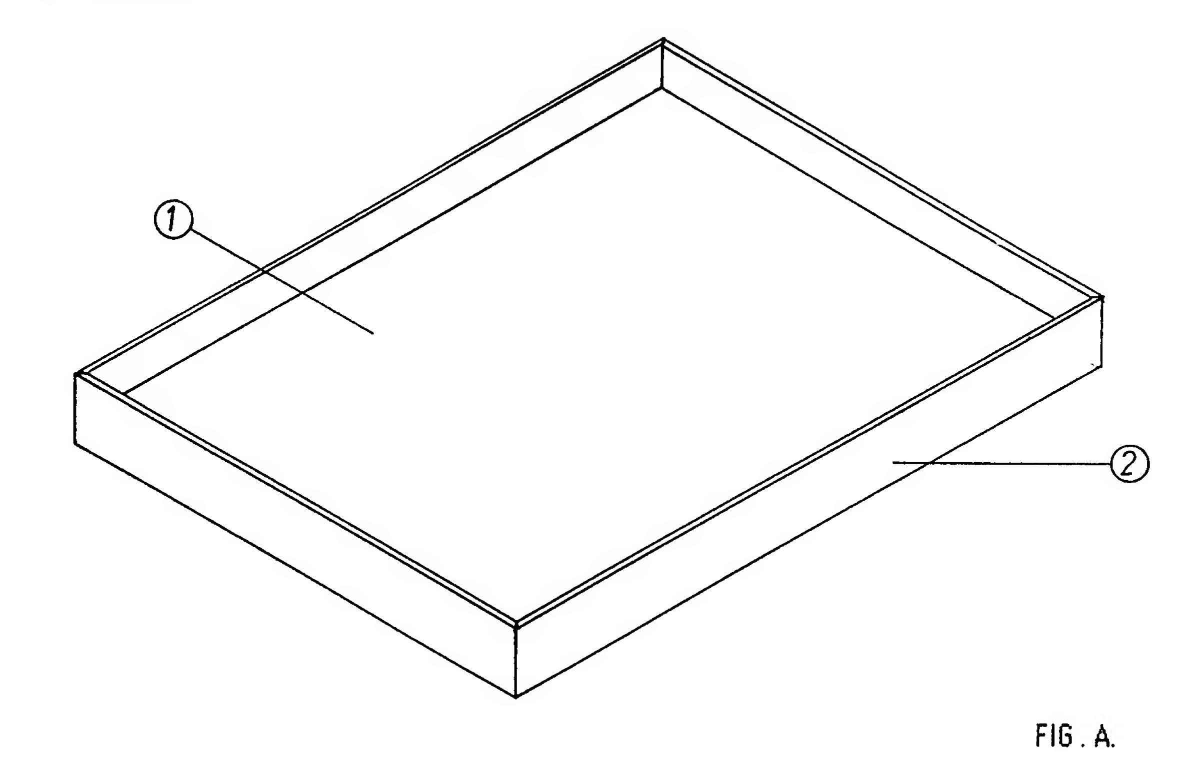


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Base	1.	Plywood.	25cm x 25cm x 14mm.
2- Sides	4.	Wood.	25,3cm x 3,2cm x 0,6cm.
		Wood glue	
	12.	Nails.	approx. 12mm long.

6- CONSTRUCTION DETAILS

1.4cm.
25cm.
25cm.

Fig.1.

Cut the 14mm thick plywood to the sizes indicated (25cm x 25cm) and smooth down all surfaces.

3.2cm
1.4cm.
3mm.

Fig.2.

Cut the four sides to the required lengths and rebate each piece as indicated in the sketch. Mitre the ends to form a neat joint at each corner. Smooth down all surfaces.

Mitre.

Apply wood glue to the edges of the base and the rebate areas of the sides as well as to the mitred ends. Using the nails fix the sides to the base.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$ 8.50

8- METHOD OF USE

As required for the dissection of small animals.

9- COMMENTS

1- ITEM

STRETCHING BOARD.

2- PURPOSE

For stretching insects in biology experiments.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

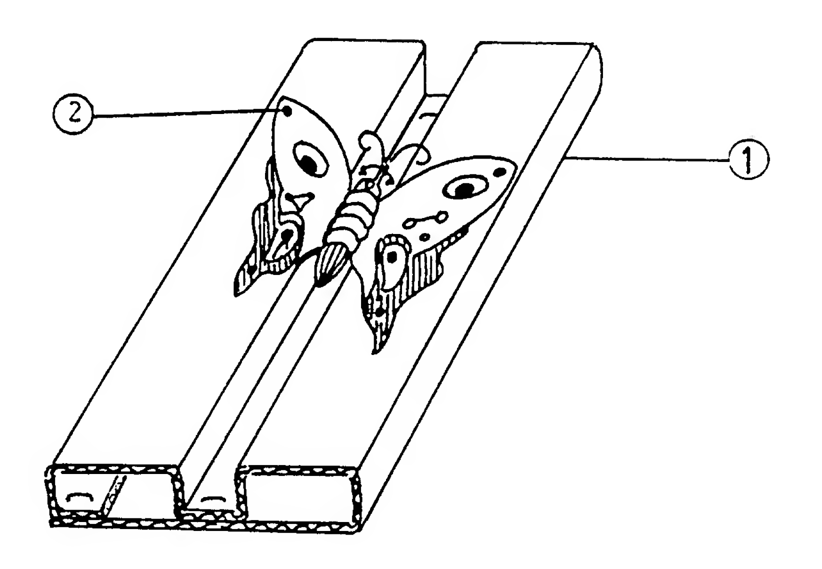
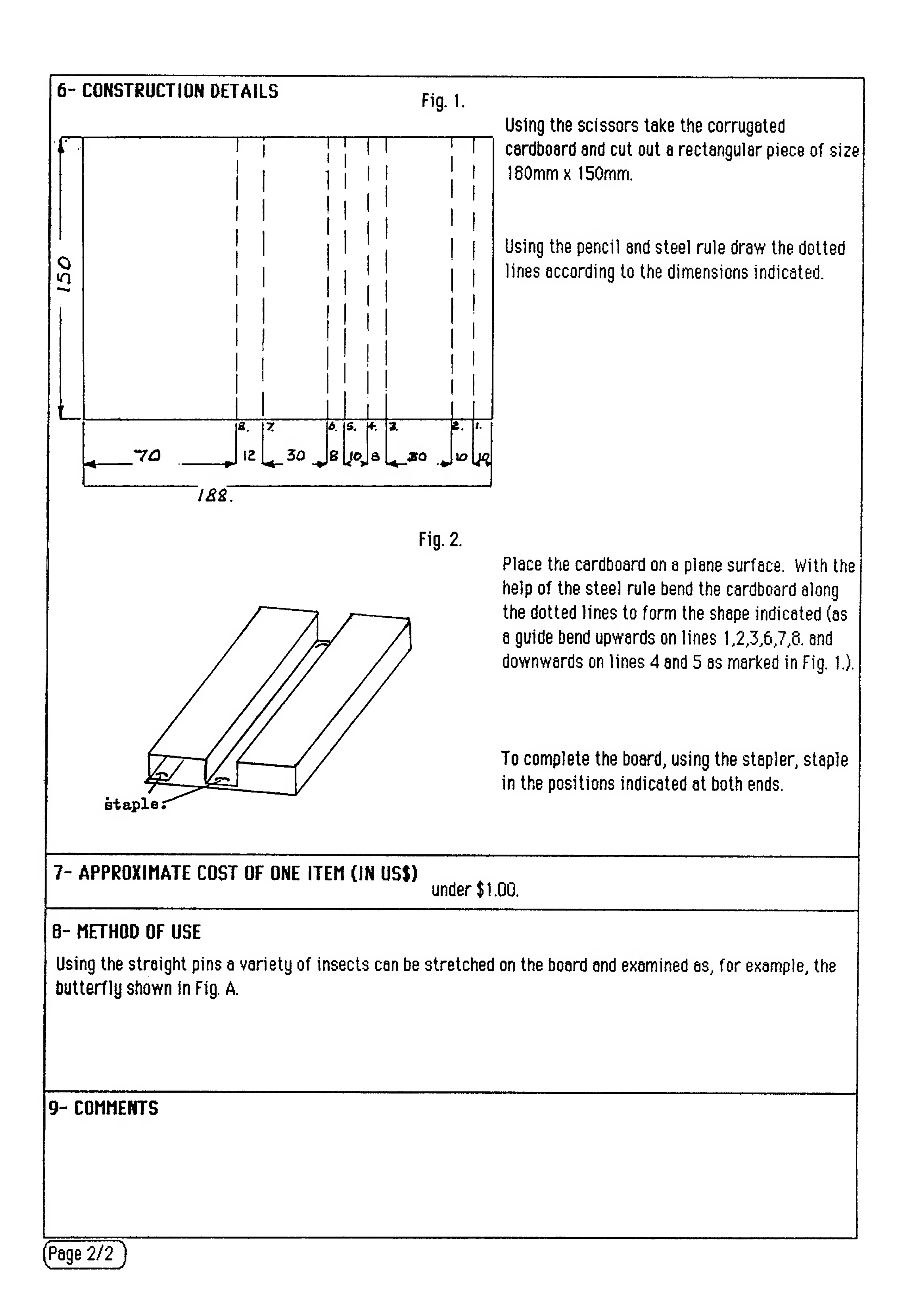


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Board.	1.	Corrugated Cardboard.	188mm x 150mm x 2mm.
2- Straight pins.	1pkt.		

Tools: Steel rule; pencil; scissors; stapler.



6- CONSTRUCTION DETAILS

Fig. 1.

Using the scissors take the corrugated cardboard and cut out a rectangular piece of size 180mm x 150mm.

Using the pencil and steel rule draw the dotted lines according to the dimensions indicated.

Fig. 2.

Place the cardboard on a plane surface. With the help of the steel rule bend the cardboard along the dotted lines to form the shape indicated (as a guide bend upwards on lines 1,2,3,6,7,8. and downwards on lines 4 and 5 as marked in Fig. 1.).

To complete the board, using the stapler, staple in the positions indicated at both ends.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

under $1.00.

8- METHOD OF USE

Using the straight pins a variety of insects can be stretched on the board and examined as, for example, the butterfly shown in Fig. A.

9- COMMENTS

1- ITEM

ELEMENTARY COUNTING DISC.

2- PURPOSE

For elementary counting practice.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids.
National Educational Equipment Centre. Lahore- 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

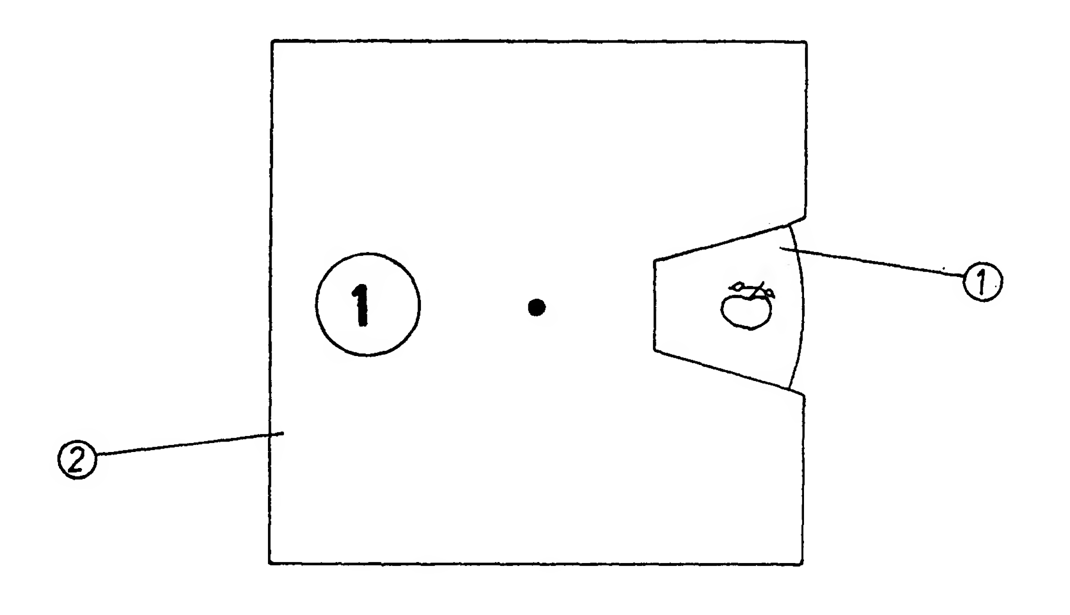


FIG. A.

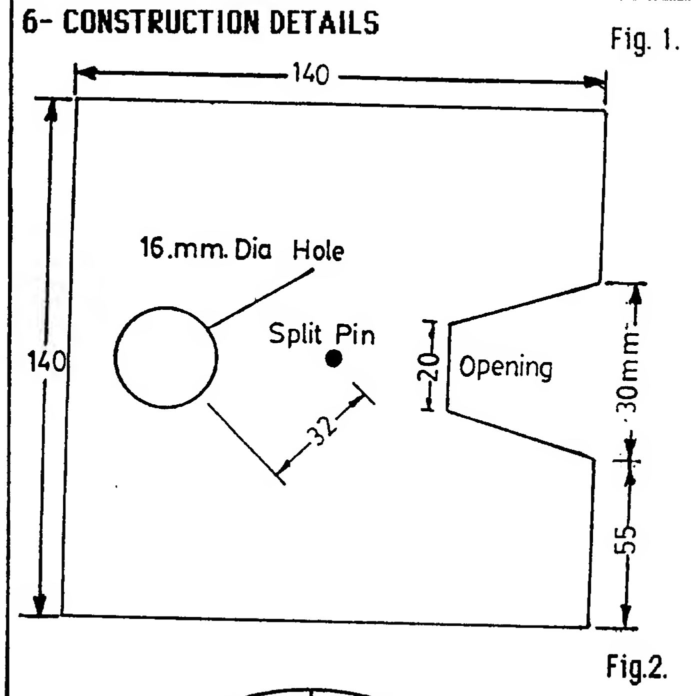
5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Frame.	1.	Hardboard.	140mm x 140mm.
2- Disc.	1.	Hardboard.	135mm diameter.
	1.	White paper.	130mm diameter.
	1.	Split paper fastener.	
		Gum.	
		Pencil.	

Tools: Woodsaw; hammer; chisel.

6- CONSTRUCTION DETAILS

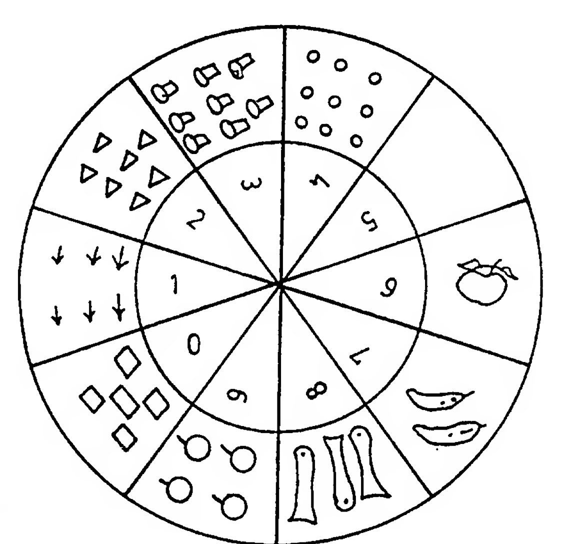
Fig. 1.



To make the frame cut out a piece of hardboard of size 140mm x 140mm. Mark out the position of the 16mm dia. hole, the centre position and the 20mm x 30mm opening. Using a small chisel cut out the 16mm dia. hole and also cut out the opening. Make a hole in the centre for the split fastener pin. Remove all rough edges with sandpaper.

Note that the length of the side opening will depend upon the space used for the pictures on the disc.

Fig.2.



To make the disc cut out a piece of hardboard of 135mm diameter. Next take a piece of white paper and cut out a circle of 130mm dia. Mark out the face of this circle with the pictures and numbers as shown in the sketch. Paste this paper circle onto the circular piece of hardboard. Make a hole through the centre position for the pin.

To assemble place the disc behind the frame. Insert the split pin in the centre hole and bend it open behind the disc.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.5.

8- METHOD OF USE

Rotate the disc until a number appears inthe round hole. The picture corresponding to the number appears in the side opening.

9- COMMENTS

1- ITEM

SIMPLE ABACUS.

2- PURPOSE

For addition, subtraction, counting, etc. in primary school mathematics.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids.
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

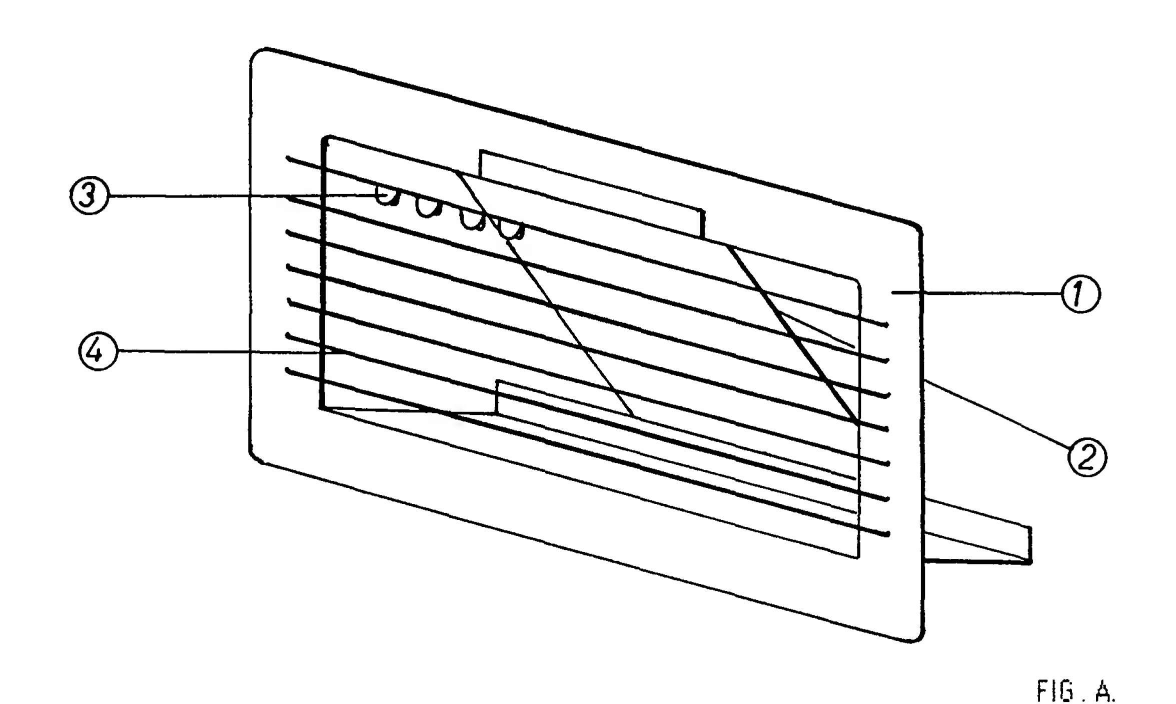


FIG . A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Frame.	1.	Cardboard.	250mm x 200mm.
2 - Stay.	1.	Cardboard.	190mm x 120mm.
3 - Beads.	100.	Cardboard.	30mm x 15mm.
4 - Threads.	1.	Thread.	1 roll.

6- CONSTRUCTION DETAILS

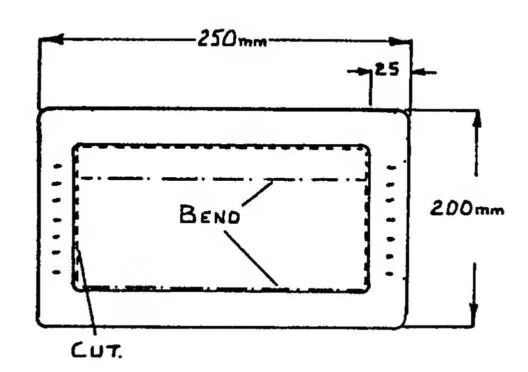


Fig. 1.

Using the scissors cut a sheet of stiff cardboard to a size of 250mm x 200mm. Mark out the card as indicated in the sketch and cut around the three sides indicated by the dotted lines. Bend this inner piece backwards, along the bottom broken line, and then bend a 25mm high upstand from the outer edge. Make seven small holes, evenly spaced, in the two sides of the frame.

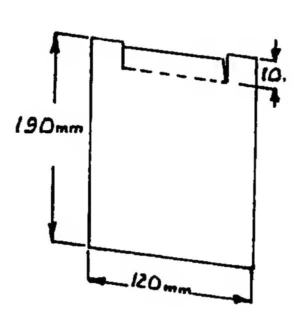


Fig. 2.

From a similar piece of cardboard mark out and cut the stay as indicated in the sketch. Cut the two slits at approx. 100mm apart and bend along the dotted lines.

Complete the assembly of the abacus by passing the thread through the seven holes and tying at the back; staple the stay to the rear upstand of the frame, and the top of the frame, as shown in Fig. A.

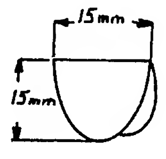


Fig. 3.

From a piece of cardboard cut out 100 beads as indicated in the sketch. Colour the beads in groups of 10, as required.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50

8- METHOD OF USE

9- COMMENTS

Different concepts such as addition, subtraction, multiplication and division can be taught and explained with this apparatus.

1- ITEM

MATHEMATICAL MODEL.

2- PURPOSE

To show that $(A+B)^2$ is equal to $A^2 + B^2 + 2AB$

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

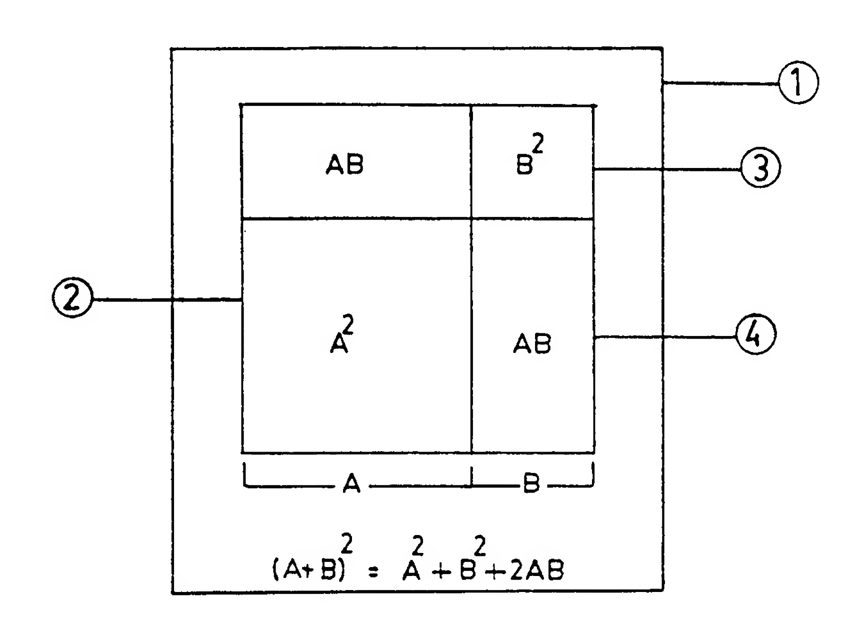


FIG. A.

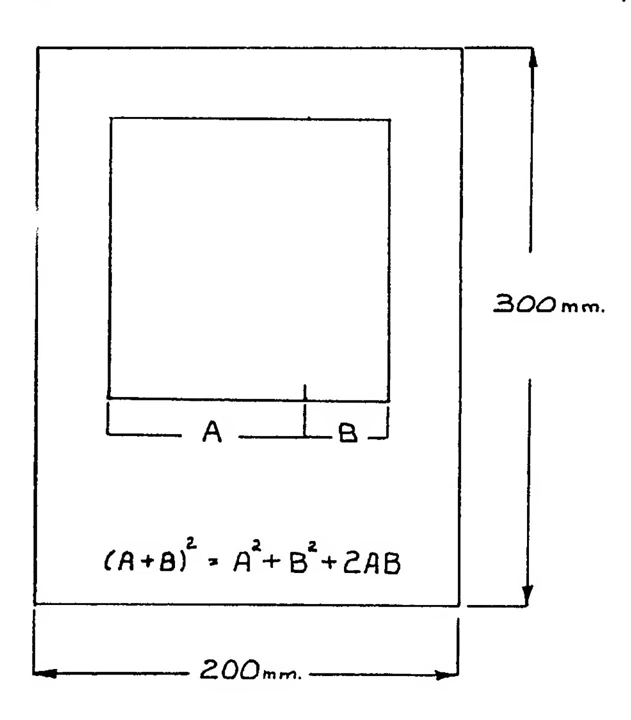
5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Baseboard	1.	Stiff cardboard.	300mm x 200mm.
2- Square A	1.	" "	70mm x 70mm.
3- Square B	1.	" "	30mm x 30mm.
4- Rectangle AB	2	" "	70mm x 30mm
		White paper.	
		Gum.	

Tools: Scissors; marker; set square.

6- CONSTRUCTION DETAILS

Fig. 1.



To construct the baseboard paste a large piece of white paper onto a piece of stiff cardboard. Using the scissors cut out a rectangle of size 300mm x 200mm. With the help of the set square and marker draw a square of size 100mm x 100mm. To complete the baseboard neatly mark in under the square the information shown in the sketch.

With the help of the scissors cut, from the remaining cardboard, the following pieces -

One square of size 70mm x 70mm.
One square of size 30mm x 30mm.
Two rectangles of size 70mm x 30mm

Neatly mark on the 70mm square - A^2
Neatly mark on the 30mm square - B^2
Neatly mark on the rectangles - AB

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.5.

8- METHOD OF USE

Put the square A, square B and the two rectangles AB onto the square on the baseboard as shown in Fig. A.
This shows that $(A + B)^2 = A^2 + B^2 + 2AB$.

9- COMMENTS

1- ITEM

MODEL OF A CIRCLE.

2- PURPOSE

To find the area of a circle.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids.
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

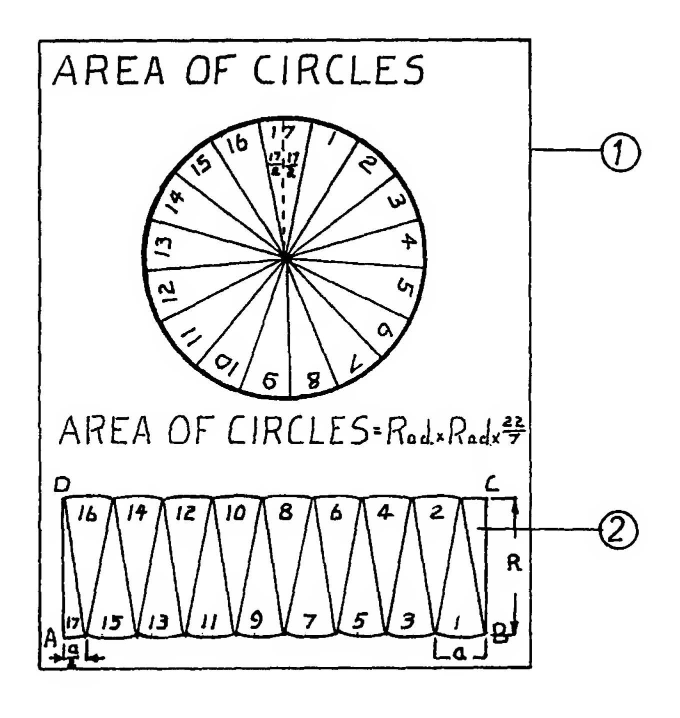


FIG . A.

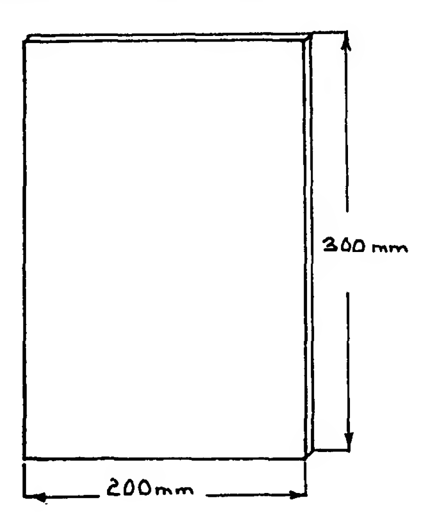
5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Baseboard.	1.	Stiff cardboard (or hardboard).	300mm x 200mm.
2 - Segments.	1.	White paper.	---

Tools: Scissors; gum; rule; compass; pencil.

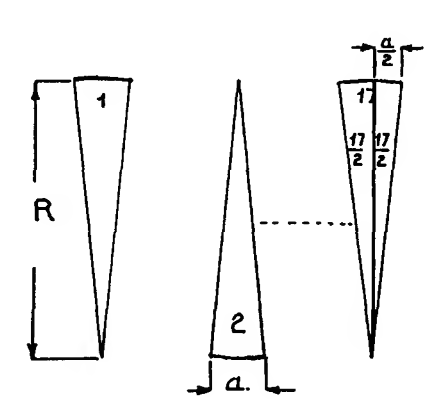
6- CONSTRUCTION DETAILS

Fig. 1.



From a piece of cardboard (or hardboard) cut out a rectangle of size 300mm x 200mm. Paste on one face a sheet of white paper. Using a compass draw a circle on the paper.

Fig. 2



On a second piece of white paper draw a circle of the same size as the one drawn previously. Divide this circle into 17 equal segments and using the scissors,cut out these segments. Mark the segments with numbers from one to seventeen. Cut the 17th segment in half as shown in the sketch.

Arrange the segments in the form of a rectangle below the circle on the card and complete the details on the card as shown in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50

8- METHOD OF USE

Calculate the area of the rectangle, which is the sum of the 17 segments which is equal to the area of the circle. Refer to Fig. A. - the full circle consists of 17 segments. Arrange these segments in such a way as to form a rectangle, ABDC. Let us consider the curved length of a segment = a, and that of a half segment = $\frac{a}{2}$

Area of rectangle = AB x BC = $(8a + \frac{a}{2})$ BC., which is the same as $\frac{\text{Circumference}}{2} \times R$,

Since circumference = $2 \times \frac{22}{7} \times R$ (i.e. $2 \pi R$) then Area of circle = $\frac{2 \times 22 \times R}{2 \times 7} \times R = \frac{22}{7} \times R^2$

9- COMMENTS

1- ITEM

RIGHT ANGLED TRIANGLE MODEL.

2- PURPOSE

To show that the area of a right angled triangle is equal to $\frac{\text{Base x Perpendicular}}{2}$

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids.
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

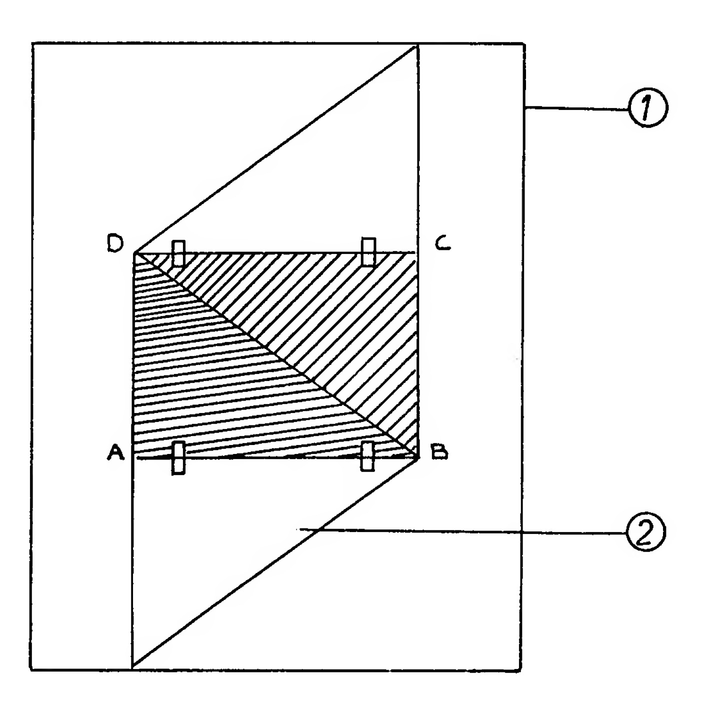


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Base.	1.	Cardboard.	300mm x 200mm
2 - Triangles.	2.	Cardboard.	80mm x 40mm
		White paper.	
		Gum.	
		Scotch tape.	
		Marker.	

Tools: Scissors; rule

6- CONSTRUCTION DETAILS

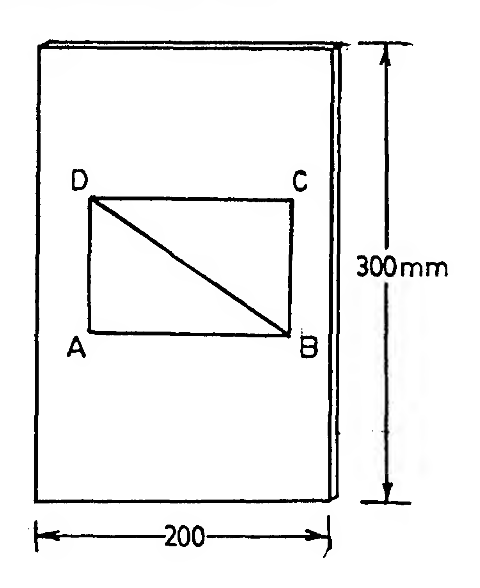


Fig. 1.

Cut a stiff piece of cardboard to a size of 300mm x 200mm. Paste a piece of white paper onto the card and trim it to the size of the card. Draw a rectangle of size 80mm x 40mm on the paper, as indicated by ABCD in the sketch, and draw the diagonal BD.

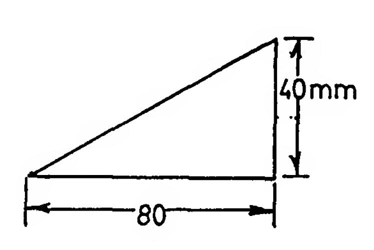


Fig. 2.

From a piece of cardboard cut two triangles as indicated in the sketch. Fix these two triangles to the sides AB and CD of the rectangle with the help of the scotch tape as shown in Fig. A. Ensure that when the two triangles are folded they fit evenly over the rectangle.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50.

8- METHOD OF USE

Fold the two triangles over the rectangle. This indicates that:-

$$\text{Area of triangle} = \frac{\text{Area of rectangle}}{2} = \frac{AB \times BC}{2} = \frac{\text{Base} \times \text{Perpendicular}}{2}$$

9- COMMENTS

1- ITEM

COUNTING TRAY TO BASE 5.

2- PURPOSE

For teaching four fundamental rules of mathematics when counting to Base 5.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

① ②

ADDITION AND SUBTRACTION

±	1	2	3	4	10
1	2	3	4	10	11
2	3	4	10	11	12
3	4	10	11	12	13
4	10	11	12	13	14
10	11	12	13	14	20

MULTIPLICATION AND DIVISION

× ÷	1	2	3	4	10
1	1	2	3	4	10
2	2	4	11	13	20
3	3	11	14	22	30
4	4	13	22	31	40
10	10	20	30	40	100

FIG. A.

5- MATERIALS FOR CONSTRUCTION

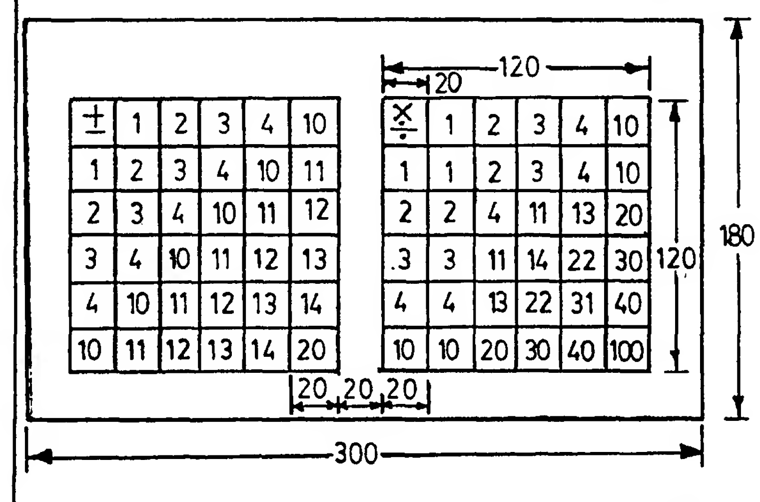
Components	Qty	Materials Required	Dimensions
1 - Base.	1.	Cardboard.	300mm x 180mm.
2 - Cover.	1.	White paper.	300mm x 180mm.

Tools: Scissors; rule; marker; gum.

6- CONSTRUCTION DETAILS



Fig. 1.



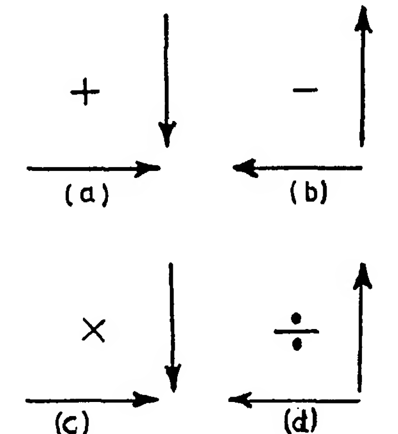
±	1	2	3	4	10
1	2	3	4	10	11
2	3	4	10	11	12
3	4	10	11	12	13
4	10	11	12	13	14
10	11	12	13	14	20

×/÷	1	2	3	4	10
1	1	2	3	4	10
2	2	4	11	13	20
3	3	11	14	22	30
4	4	13	22	31	40
10	10	20	30	40	100

Using the scissors cut a piece of stiff cardboard to a size of 300mm x 180mm. Take a similar sized piece of white paper and, using the gum, paste this to the cardboard base.

Using the marker and rule draw the columns and rows and complete by adding the symbols and numbers as indicated in the sketch.

Fig. 2.



See method of use below.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50.

8- METHOD OF USE

1. Addition and Subtraction: The cross section of rows and columns of the additions and subtraction square, indicated by the arrows in Fig. 2.a, and b, will give the correct answer for addition and subtraction respectively e.g. if we add 1 + 2 the answer is 3 at the cross section of 1 in the row and 2 in the column.
2. Multiplication and Division: The cross section of rows and columns of the multiplication and division square, indicated by the arrows in Fig. 2. c and d, will give the correct answer for multiplication and division respectively.

9- COMMENTS

1- ITEM

SET OF ATTRIBUTE BLOCKS - GEOMETRIC MODELS.

2- PURPOSE

For use in mathematics teaching.

3- INFORMATION SUBMITTED BY

Science Equipment Centre, Lagos, Nigeria.

4- LINE DRAWING OF PROTOTYPE

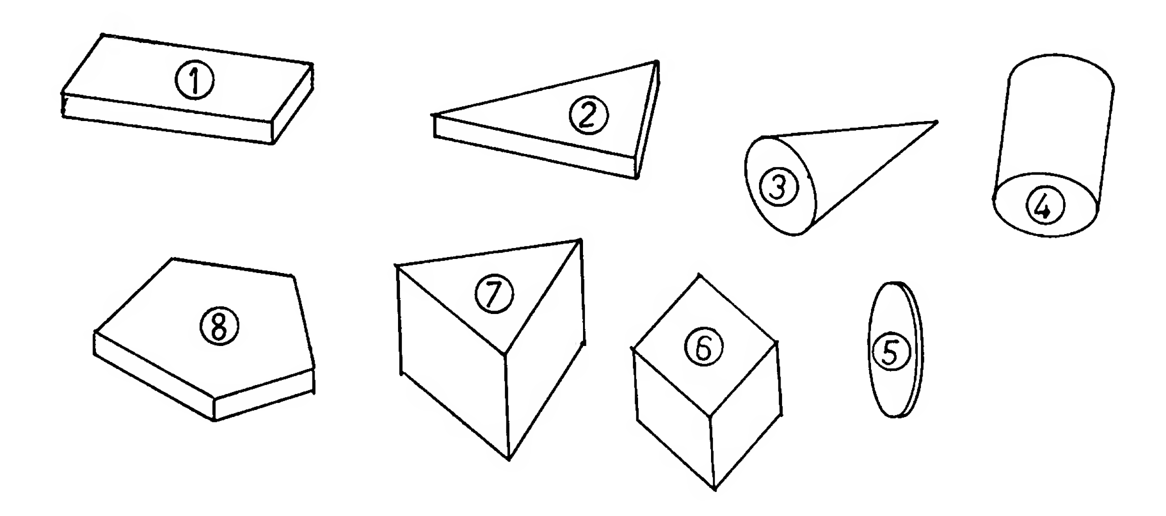


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Rectangle.	1.	Wood.	as required.
2 - Triangle.	1.	Wood.	" "
3 - Cone.	1.	Wood.	" "
4 - Cylinder.	1.	Wood.	" "
5 - Circle.	1.	Wood.	" "
6 - Cube.	1.	Wood.	" "
7 - Prism.	1.	Wood.	" "
8 - Hexagon.	1.	Wood.	" "

6- CONSTRUCTION DETAILS

The various shapes can be cut from seasoned wood. In some cases they will need to be machined on a lathe.

To keep the set in a kit form a box could also be constructed to house the set. The size of the box will depend upon the sizes of the blocks.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

8- METHOD OF USE

Either for demonstration purposes or for pupil use.

9- COMMENTS

1- ITEM

FRICTION BLOCK

2- PURPOSE

For investigating friction between different types of surfaces.

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project,
National Institute of Science and Technology, Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

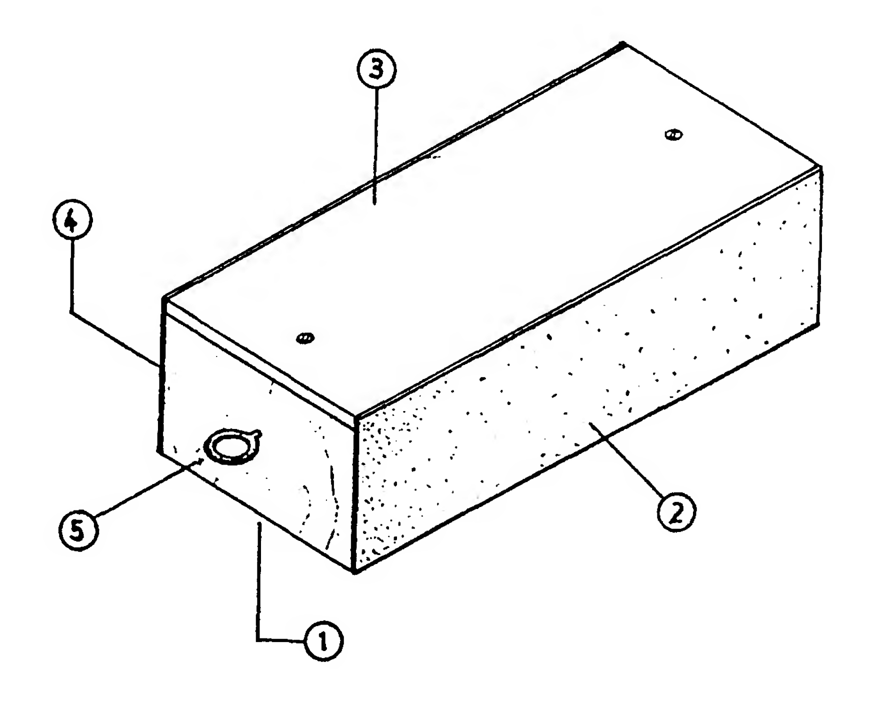
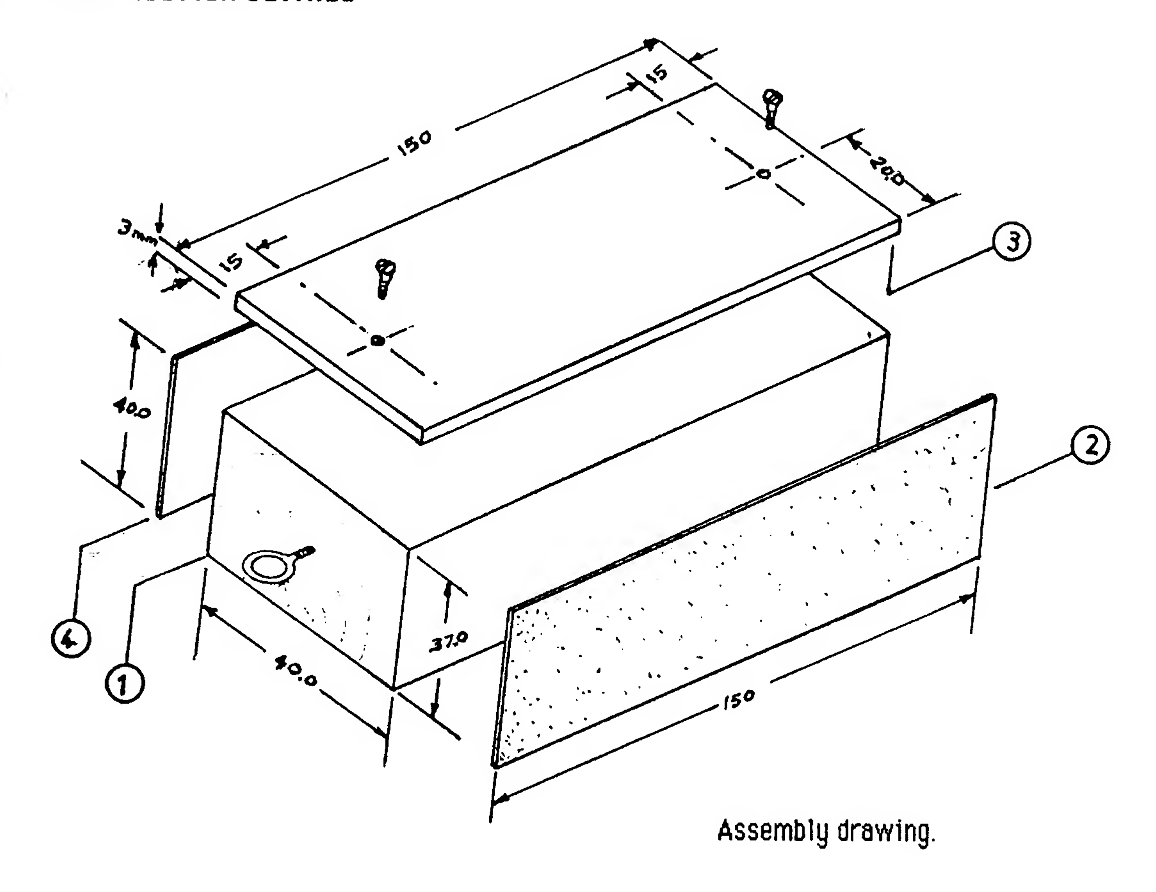


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Wood block.	1.	Wood.	150mm x 37mm x 40mm.
2- Sandpaper.	1.	Sandpaper.	150mm x 40mm.
3- Plastic sheet.	1.	Plastic sheet.	150mm x 40mm x 3mm. thick.
4- Felt paper.	1.	Felt paper.	150mm x 40mm.
5- Screw eye.	1.	Screw eye.	6mm dia.

6- CONSTRUCTION DETAILS



Assembly drawing.

Attach the different types of surfaces to the wood block, by means of glue or screws, as shown in the assembly drawing.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$2.50.

8- METHOD OF USE

Attach a spring balance and drag each surface along the table to determine the frictional force needed to start the block moving.

9- COMMENTS

Different types of boards can be placed on the table so that the frictional force of different combinations of surfaces could be determined.

1- ITEM

SIMPLE PULLEY

2- PURPOSE

For mechanics experiments and other lifting activities.

3- INFORMATION SUBMITTED BY

Sciences Equipment Centre, Lagos, Nigeria.

4- LINE DRAWING OF PROTOTYPE

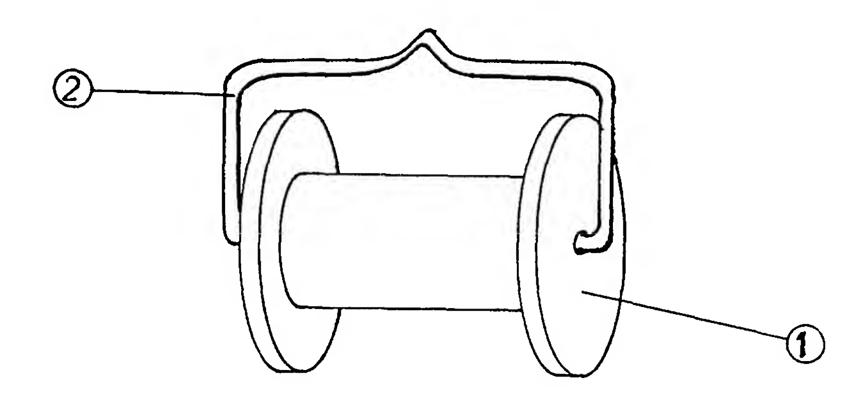


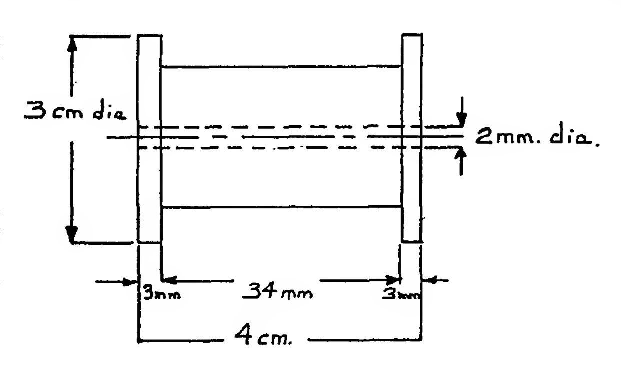
FIG . A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Pulley.	1.	Wood.	3cm dia x 4cm long.
2- Hanger.	1.	Galvanised wire.	2mm dia x 15cm long.

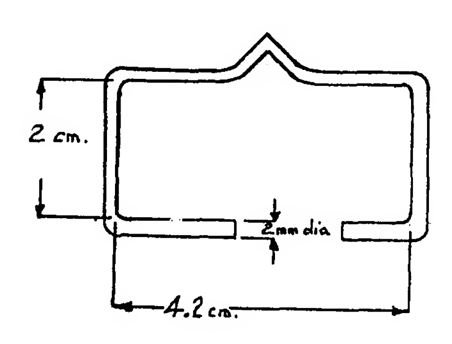
6- CONSTRUCTION DETAILS

Fig.1.



Using a lathe machine the wood to the shape indicated in the sketch. Drill a hole of 3mm dia through the length of the pulley. Smooth down all surfaces using sandpaper.

Fig. 2.



Bend the galvanised wire into the shape indicated in the sketch.

To assemble the hanger and pulley gently bend open the lower arms and slip the pulley onto the longer of the two arms. Bend back the shorter arm fitting it into the hole in the pulley.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50.

8- METHOD OF USE

When the pulley is suspended from its hanger it can be used for lifting activities.

9- COMMENTS

A "cotton reel" could also be used with a suitable hanger.

1- ITEM

CENTRE OF GRAVITY SET.

2- PURPOSE

To teach the concepts of equilibrium and centre of gravity.

3- INFORMATION SUBMITTED BY

Institute for the Promotion of Teaching Science and Technology (IPST), Bangkok, Thailand.

4- LINE DRAWING OF PROTOTYPE

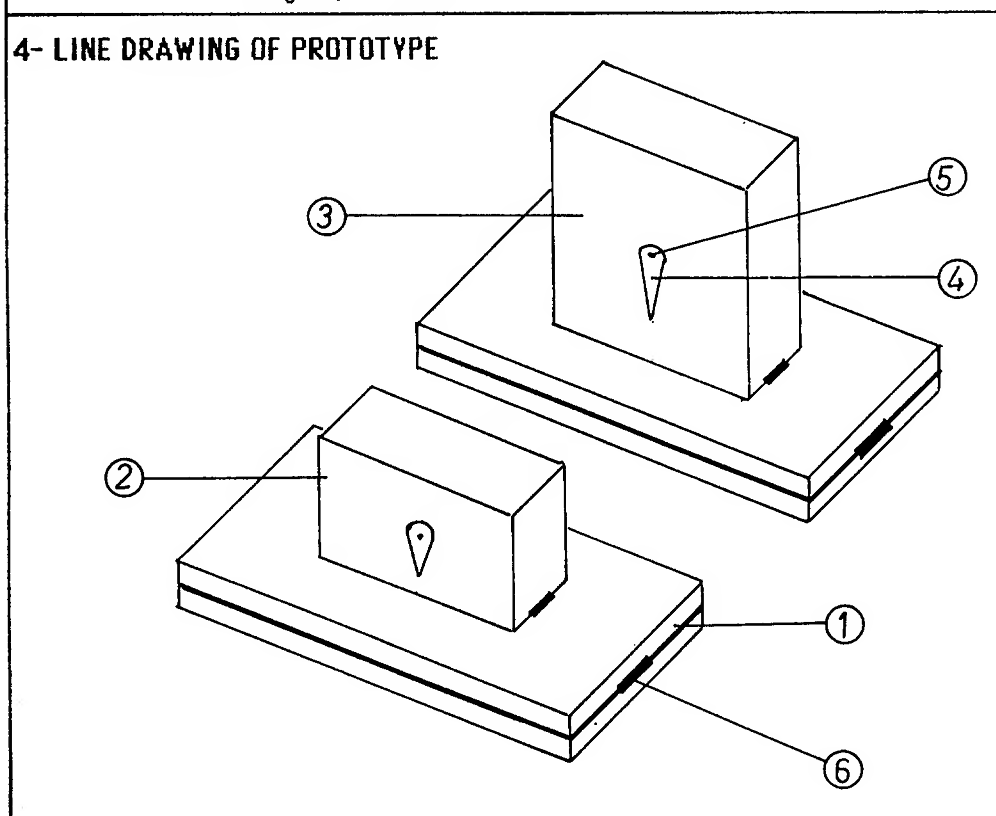


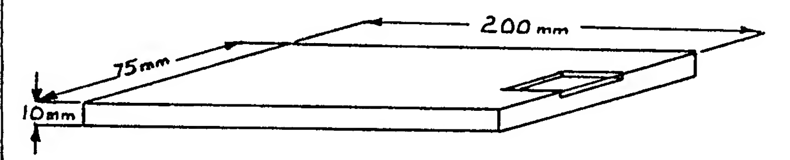
FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Bases.	4.	Plywood.	200mm x 75mm x 10mm
2 - Small block.	1.	Wood.	95mm x 95mm x 45mm.
3 - Large block.	1.	Wood.	190mm x 95mm x 45mm
4 - Needle.	2.	Metal (or plastic) sheet.	
5 - Pivot.	2.	Nail.	
6 - Hinge.	4	Metal.	

6- CONSTRUCTION DETAILS

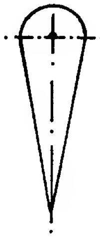
Fig. 1.



Cut from a 10mm thick sheet of plywood, four pieces of size 200mm x 75mm. Assemble two bases by joining two pieces together via a hinge. Recess the hinges into the base so that the faces lay flat when closed.

Cut a small block of wood of size 95mm x 95mm x 45mm and fix this via a hinge to the upper surface of one of the bases. Recess the hinge as before. Repeat this using the other base and a block of size 190mm x 95mm x 45mm.

Fig. 2.



From a thin piece of metal or plastic construct a needle in the shape indicated in the sketch. Using a small nail make a hole in the needle such that the needle can swing freely on the nail. Using the nail as the pivot for the needle, hammer the nail into the small block at its centre of gravity position on one face. Repeat this for the larger block.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.50.

8- METHOD OF USE

Lift the base and observe the position of the needle. The block will fall backwards when the position of the needle points outside of the base line of the block.
Lift the base of each set simultaneously. The set with the higher centre of gravity will fall backwards first.

9- COMMENTS

1- ITEM

WEIGHTLESSNESS APPARATUS.

2- PURPOSE

To teach the concept of the condition of weightlessness.

3- INFORMATION SUBMITTED BY

The Institute for the Promotion of Teaching Science and Technology (IPST), Bangkok, Thailand.

4- LINE DRAWING OF PROTOTYPE

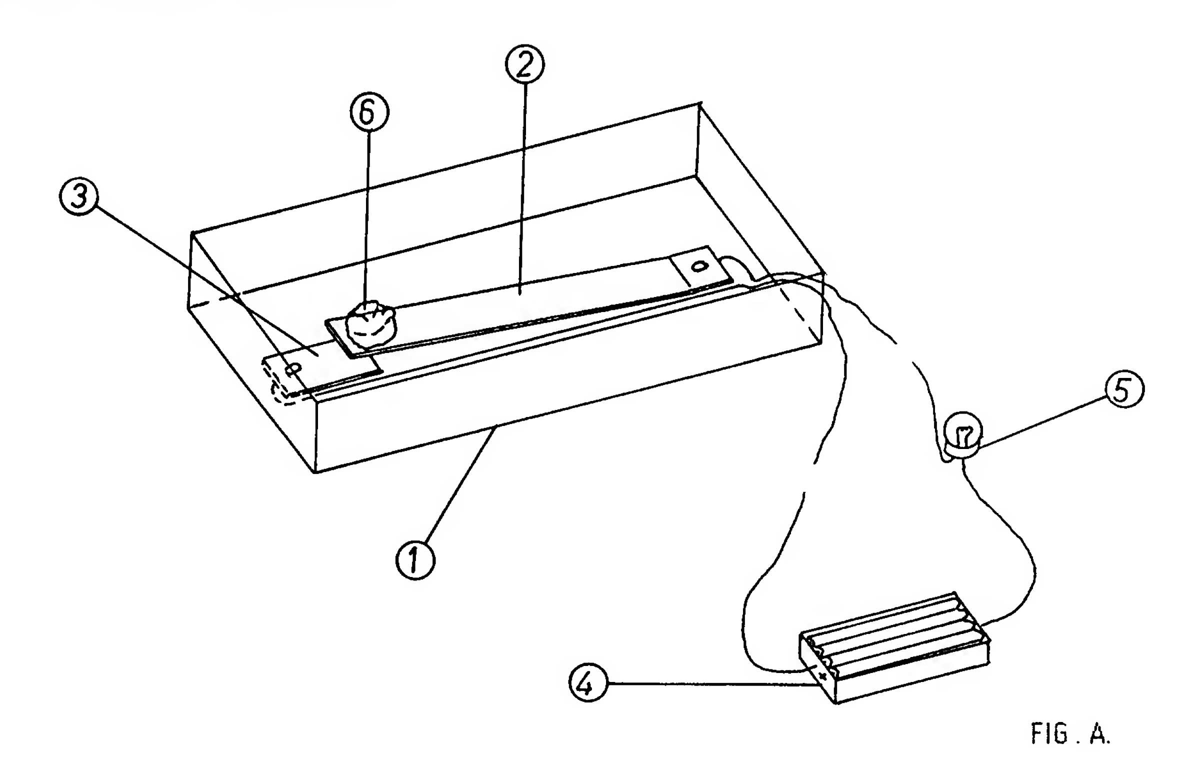


FIG . A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Box.	1.	Wood (or plastic).	150mm x 100mm x 30mm high.
2 - Contact strip 'A'.	1.	Aluminium sheet.	100mm x 15mm.
3 - Contact strip 'B'.	1.	Aluminium sheet.	20mm x 15mm.
4 - Battery.	1.	Batteries (6 volt).	---
5 - Light source.	1.	Electric torch bulb.	---
		(6 volt) and bulb holder.	---
6 - Plasticine.	1.	Plasticine.	---
	1.	Connecting wire.	approx. 2.5m.

6- CONSTRUCTION DETAILS

Cut a thin gauge aluminium or brass sheet to make the contact strips. Strip A should be approx. 100mm x 15mm wide and strip B approx. 20mm x 15mm wide.

Obtain a plastic box of approx. 150mm x 100mm x 30mm high (or make one out of wood). Fix the metal strips into the box as shown in Fig. A., using small nuts and bolts. At the same time connect the electric wire to these strips. One end of strip B should be approx. 10mm underneath strip A. Bend strip A in order that it will not be in contact with strip B. Complete the wiring of the electrical circuit by making the connections between the strips, the battery, and the bulb. Finally, place a piece of plasticine on the end of strip A so that the weight brings strip A into contact with strip B and the bulb lights up.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.50.

8- METHOD OF USE

Lift the closed-circuit box about 1.5m from the floor, and let it fall down. Observe the bulb whilst the box is falling; the light will go out.

9- COMMENTS

1- ITEM

DYNAMOMETER

2- PURPOSE

For measuring forces in mechanical experiments

3- INFORMATION SUBMITTED BY

FUNBEC, Brazil

4- LINE DRAWING OF PROTOTYPE

A

2

1

C

B

FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1. Spring	1.	Spring steel wire	0.6mm dia x 1.2m long.
2. Scale	1.	Drinking straw	5mm dia

6- CONSTRUCTION DETAILS

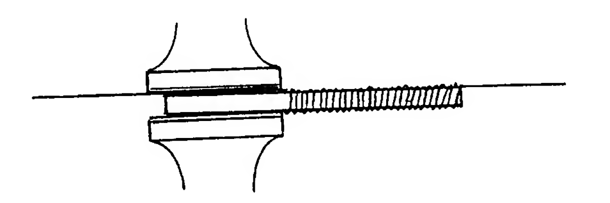


Fig. 1.

Using a 5mm piece of steel rod (or a drill) trap a 15cm length of the spring steel wire in a vice and coil the remainder around the rod as indicated in the sketch. Leave approximately 3cm of straight wire at the end after coiling. Remove the coil from the rod and slightly reduce the diameter of the last two coils so that the straw fits in tightly (see Fig A).

Bend the hooks at each end of the straight pieces and then pull outward on the hooks to elongate the spring. Do this until, on releasing one hook, the spring returns to a natural position where a small space shows between each consecutive coil.

Hang a small mass on hook 'B' and mark on the straw its value, using as a reference the last coil. Divide the stretched distance into suitable intervals, according to the mass value, to make the scale.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

Under $1.00

8- METHOD OF USE

As for any other dynamometer. By moving the straw on coil 'C' you can zero the instrument.
Other dynamometers of different capacity can be made by varying the diameter of the wire, the coil diameter, and length.

9- COMMENTS

1- ITEM

SPRING BALANCE.

2- PURPOSE

For measuring weights and forces.

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project,
National Institute of Science and Technology, Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

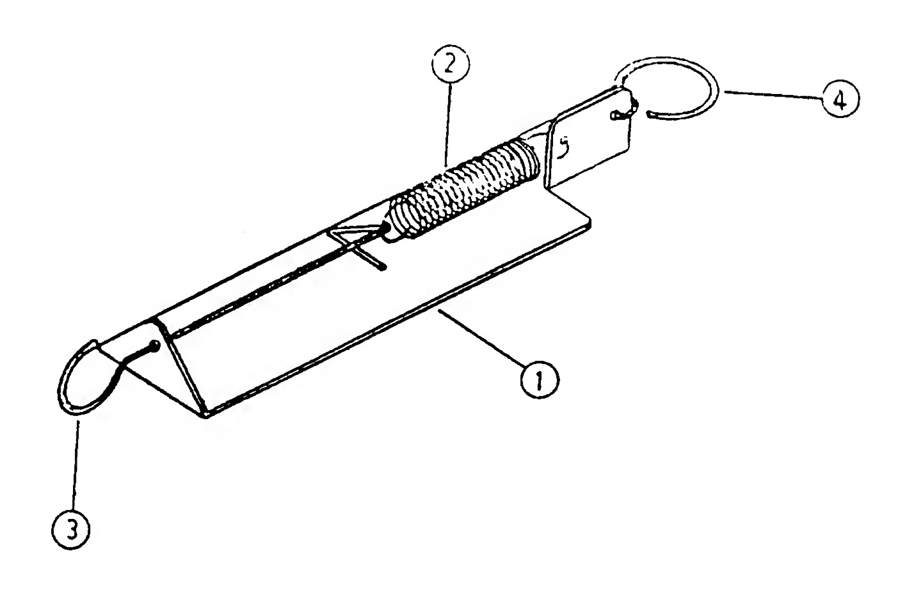


Fig. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Balance body.	1.	Aluminium sheet.	145mm x 25mm x 20 gauge.
2 - Spring.	1.	Spring (music) wire.	approx. 900mm x 24 gauge.
3 - Hook/pointer.	1.	Galvanised Iron wire.	approx. 160mm x 14 gauge.
4 - Balance hanger.	1.	Galvanised iron wire.	approx. 40mm x 14 gauge.

6- CONSTRUCTION DETAILS

Folded 90° on dotted lines

Fig. 1.

Cut Here

2.5 Radius

12.5

25.0 mm

12.0

135.0

2.0 ϕ DRILL (3 HOLES)

20.0

3.0 R.

6.0

12.0

The balanced body can be made from a piece of 20 gauge aluminium sheet or any other metal sheet that is available locally. With the above given dimensions cut the aluminium to size. Drill the 2mm dia. holes as indicated to accommodate the hook/pointer, the balance hanger and the spring. Fold 90° on the dotted lines indicated in the top sketch.

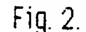
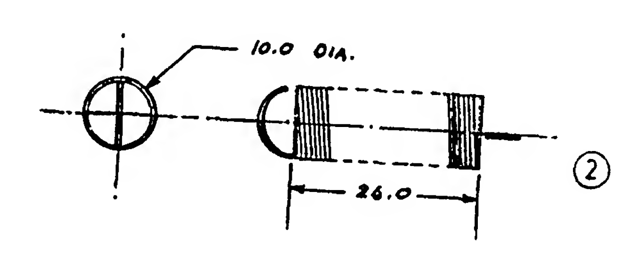


Fig. 2.

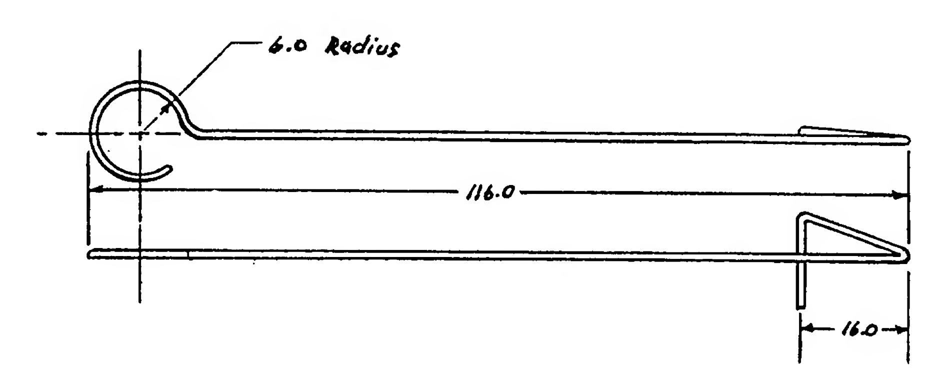


The balance spring can be made from a piece of 24 gauge music spring wire by winding the wire tightly on a piece of 10mm dia. steel rod. Make 40 turns. The spring wire ends can be bent with the use of long nose pliers.

Continued..

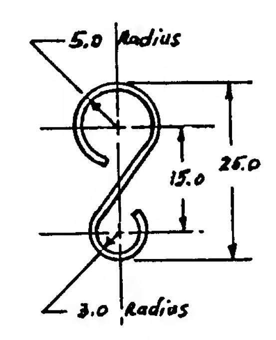
6- CONSTRUCTION DETAILS (Continued)

Fig. 3.



Using 14 gauge galvanised iron wire construct the hook/pointer as shown.

Fig. 4.



Using 14 gauge galvanised iron wire construct the balance hanger according to the dimensions given.

7- APPROXIMATE COST OF ONE ITEM (in US $)

$3.50.

8- METHOD OF USE

Direct weighing.

9- COMMENTS

To calibrate the balance: (1) Paste a thin sheet of cardboard on the face of the balance body.
(2) With balance hanging vertically without any load, mark the zero reading on the cardboard sheet.
(3) With the use of a standard weights set calibrate the balance with the desired weight intervals. (Limit the load to 70g or lower for a balance using 24 gauge wire. To increase the capacity of the balance use heavier gauge wire).

1- ITEM

REACTION FORCE APPARATUS.

2- PURPOSE

To teach the concept of reaction force.

3- INFORMATION SUBMITTED BY

The Institute for the Promotion of Teaching Science and Technology (IPST).
Bangkok, Thailand.

4- LINE DRAWING OF PROTOTYPE

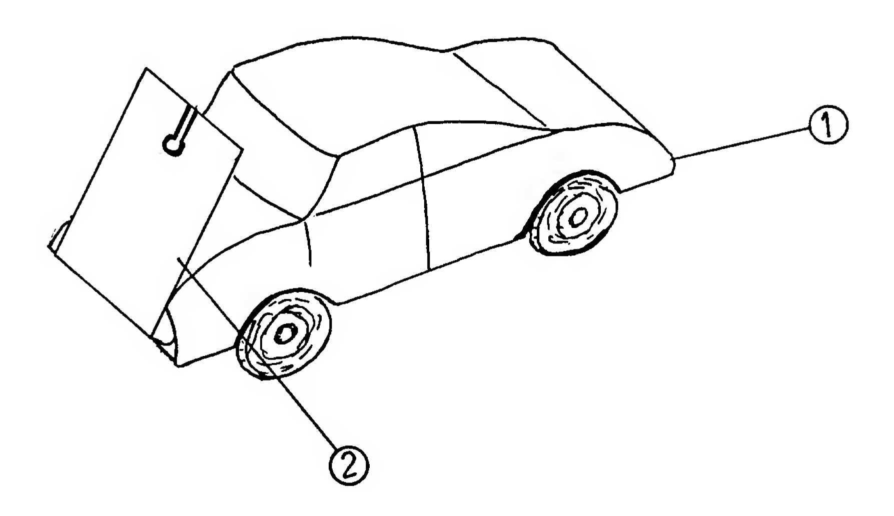


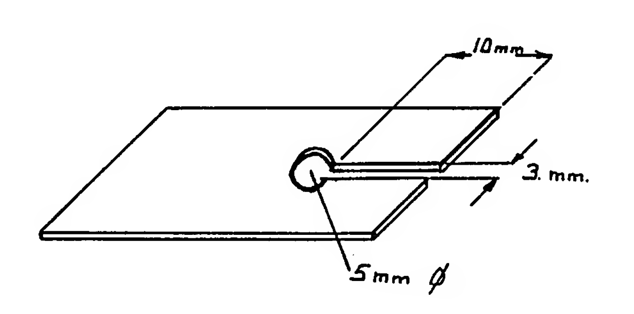
FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Car.	1.	Toy car.	--
2- Balloon holder.	1.	Tin (or plastic) sheet.	20mm x 100mm long.
	1.	Balloon.	

6- CONSTRUCTION DETAILS

Fig. 1.



To make the balloon holder cut out a piece of metal (or plastic) sheet to form a strip of 100mm long x 20mm wide. (Actual size will depend upon the size of the car obtained). Drill a 5mm dia hole and cut a slot as indicated in the sketch.

Fix the balloon holder to the front (or back) of the car, as indicated in Fig.A., with a strong adhesive or a nut and bolt.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.75.

8- METHOD OF USE

Blow up the balloon and put it into the slot of the balloon holder. Release the balloon and observe what happens. The car will run in the opposite direction to that of the air blowing out of the balloon.

9- COMMENTS

1- ITEM

SIMPLE ACTION AND REACTION CART.

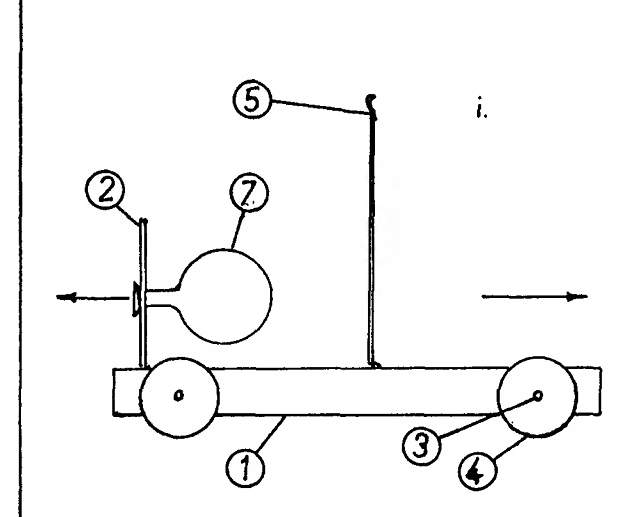
2- PURPOSE

Action and reaction are equal and opposite. (Newton's third law of motion).

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids.
National Educational Equipment Centre. Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE



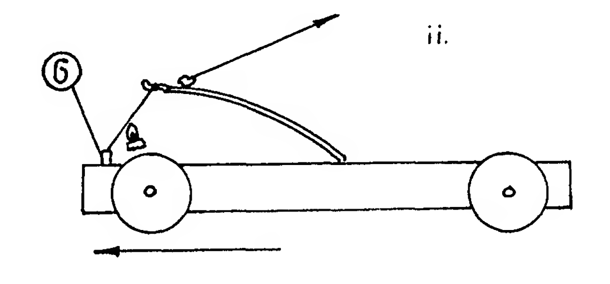


Fig. A.

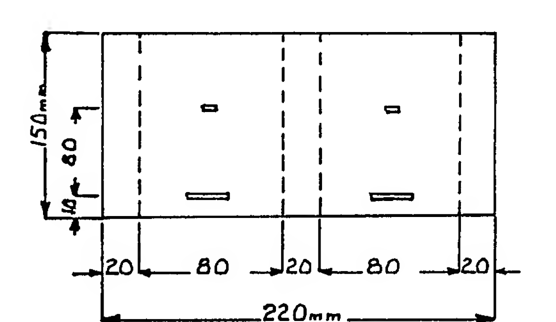
5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Cart body.	1.	Cardboard.	220mm x 150mm.
2- Balloon screen.	1.	Cardboard.	105mm x 80mm.
3- Axle.	2.	Wood.	5mm dia x 80mm long.
4- Wheels.	4.	Hardboard.(or bottle lids).	approx. 40mm dia.
5- Spring.	1.	Metal sheet.	24 gauge x 130mm x 10mm.
6- Hook.	1.	Iron wire.	approx. 50mm.
7- Balloon.	1.	Balloon.	
		Thread.	
		Paper.	
	4.	Nails.	

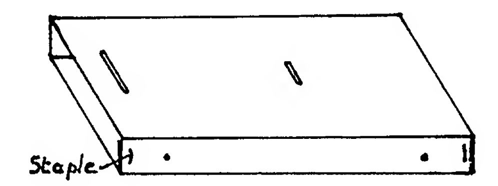
Tools: Hammer; Scissors;Saw; tin snips.

6- CONSTRUCTION DETAILS

Fig.1.



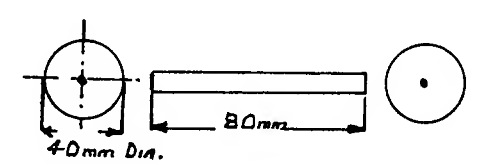
a. Using the scissors cut out the cart to a size of 220mm x 150mm. Mark out the position of the dotted lines shown in Fig.1.a. and also the two slots of 25mm x 1mm and 10mm x 1mm respectively. Cut the slots and then bend the cardboard along the dotted lines to form the cart indicated in 1.b. Staple the overlapping faces together.



b.

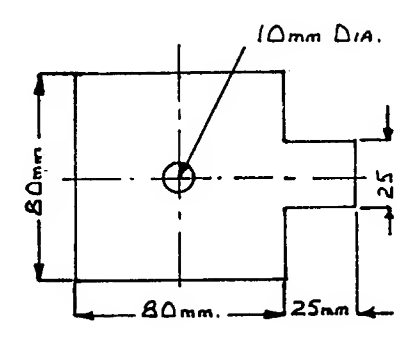


Fig.2.



To make the axles cut two pieces of 5mm dia, wooden rod to the required length. From the hardboard (or use bottle lids) cut out four wheels. Make a hole through the centre of the wheels using a nail. Place the axles inside the cart at approx. 20mm from each end and nail the wheels to the axles.

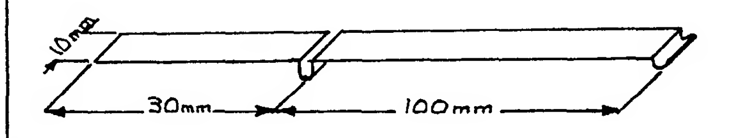
Fig.3.



Mark out on a piece of cardboard the balloon screen to the sizes shown in the sketch. Using the scissors, cut out the screen and the hole at the centre.

6- CONSTRUCTION DETAILS (Continued)

Fig.4..



From a piece of metal sheet cut a strip to the size 130mm x 10mm. Bend this strip to the shape indicated in the sketch.

Using a piece of steel wire construct a hook to fit into the 25mm slot.

7- APPROXIMATE COST OF ONE ITEM (in US $)

$0.5

8- METHOD OF USE

Fix the balloon into the balloon screen and hold in place with a small paper tube inserted into the balloon mouth and tied with thread. Inflate the balloon with air and insert the screen into the slot. Release the air from the balloon and the cart will move as indicated in Fig. A.i. Remove the screen from the cart and place the hook in the same slot. Using the thread tie the spring back onto the hook. Place a small piece of card (or paper) onto the spring as shown in Fig. A.ii. Burn the thread to release the spring. Action of the piece of card moving forward and the reaction of the card moving backward are indicated by the arrows.

9- COMMENTS

1- ITEM

EQUIPMENT FOR MECHANICAL RESONANCE STUDIES.

2- PURPOSE

For studying mechanical resonance phenomena.

3- INFORMATION SUBMITTED BY

FUNBEC, Brazil.

4- LINE DRAWING OF PROTOTYPE

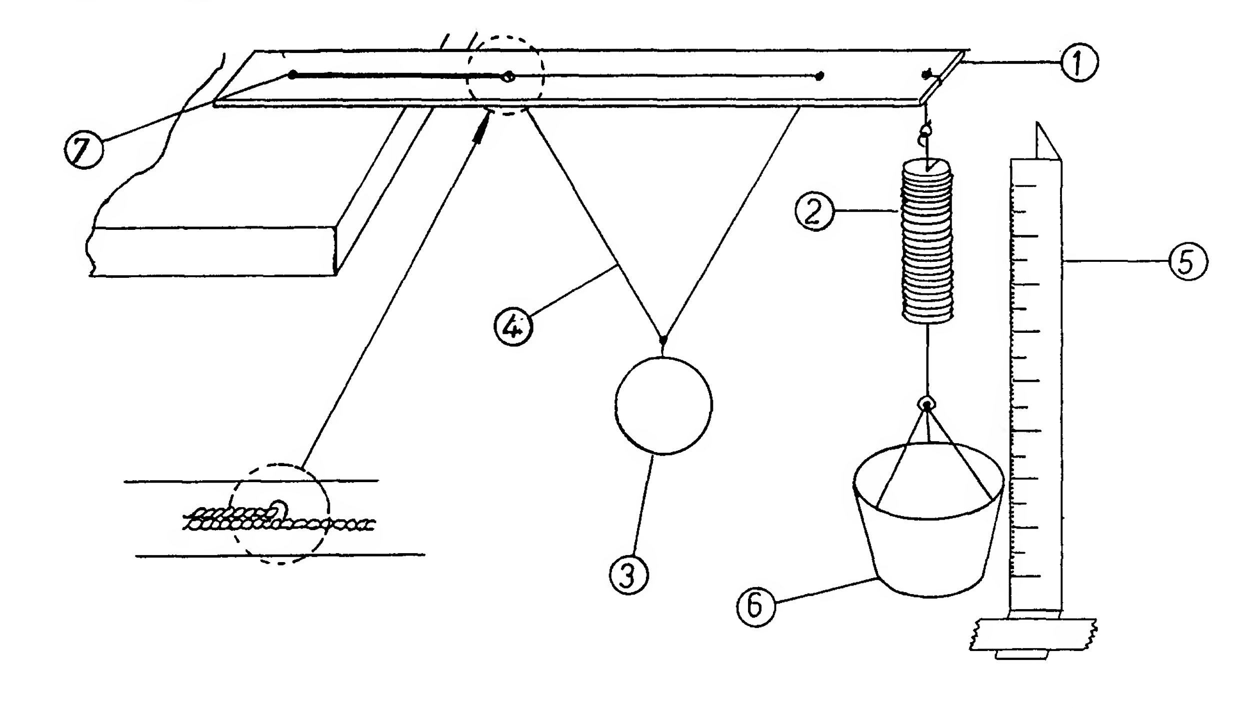


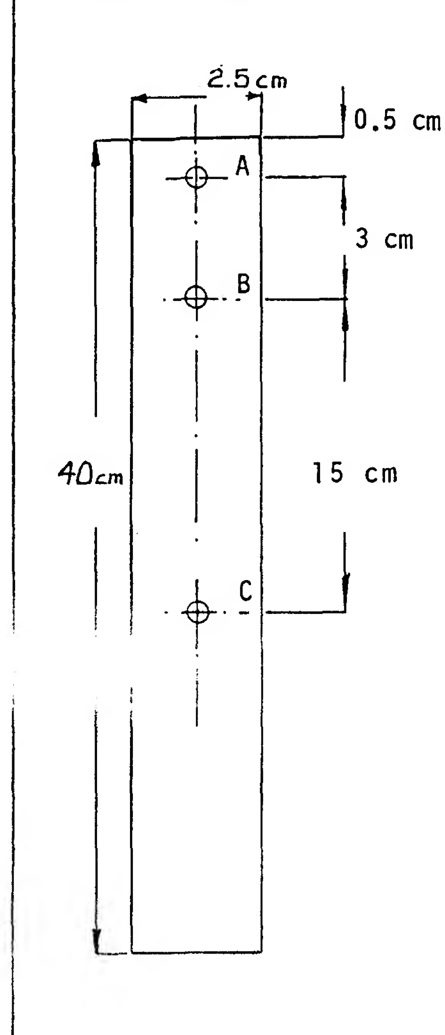
FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Woodstrip.	1.	Wood.	40cm x 2.5cm x 0.5cm.
2- Spring.	1.	Steel spring wire	1.5cm dia. x 5cm long. (size of spring)
3- Swing bob.	1.	Brass or steel etc.	100 to 200 gm.
4- String.	1.	String or cord.	1.5m long.
5- Scale.	1.	Cardboard	2cm x 30cm.
6- Container.	1.	Small plastic cup.	
7- Fixing point.	1.	Clamp	
		Several masses.	varying from10 to 50 gm.
		Small screw.	---

6- CONSTRUCTION DETAILS

Fig. 1.



Cut a wooden strip of 40cm x 2.5cm x 0.5cm and drill three holes of 3mm dia as indicated in the sketch.

To assemble the apparatus clamp the wooden strip onto a table top in such a way that the strip remains horizontal and hole 'C' is approximately 10cm away from the table edge. Take the string and push one end, from the underside of the strip, through hole 'C' and the other end through hole 'B'. Join and fix them at the fixing point. Tie the swing bob to the string between holes 'B' and 'C'. Notice that the pendulum length can be changed, therefore the period can be changed.
Using a piece of string suspend the spring and container from hole 'A'. Finally prepare a scale in such a way that it stands vertical from the bottom end folded outwards and scotch taped to a firm surface.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

Under $1.00.

8- METHOD OF USE

Place masses of 10gm to 50gm in the container and allow the pendulum to swing. Measure the maximum container oscillating amplitude. Change the pendulum frequency (length) and relate the resonance amplitude [illegible] frequency. Observe what happens when there is resonance pendulum movement and loaded container movement.

9- COMMENTS

Plot a graph relating pendulum frequency to container oscillating amplitude. Also notice what happens when giving intermittent hard strokes to the end of the wooden strip without any initial swing of the pendulum.

1- ITEM

AIR AND WATER WHEEL.

2- PURPOSE

To demonstrate the concept of wind and water energy.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

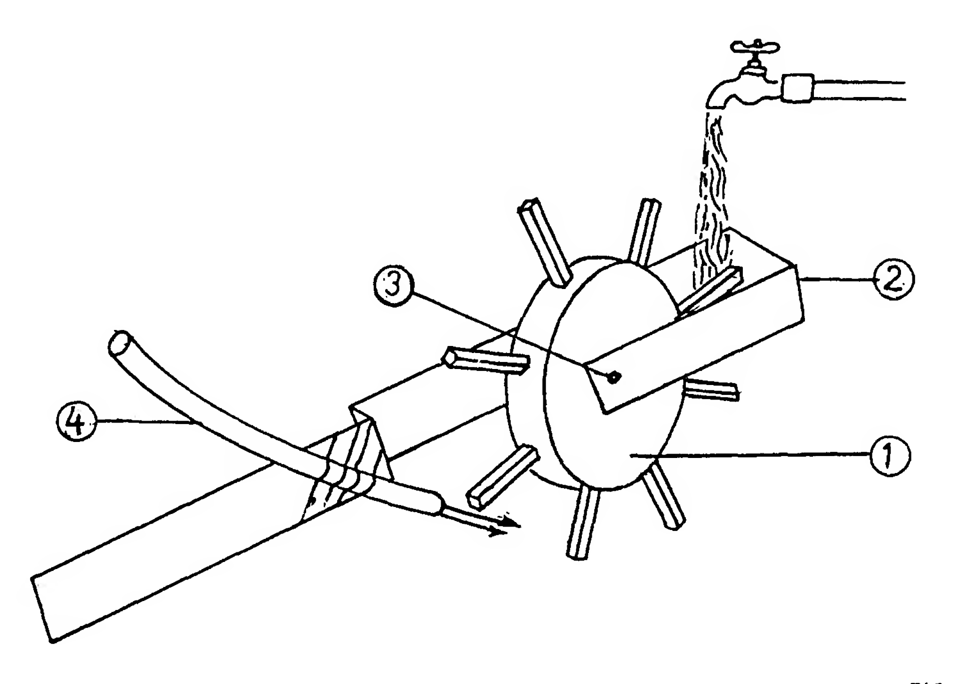


FIG . A.

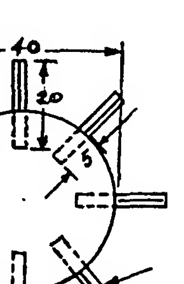
5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Wheel.	1.	Styrofoam.	40mm dia x 15mm thick.
2 - Holder.	1.	Metal sheet.	230mm x 12mm.
3 - Axle.	1.	Nail.	approx. 25mm long.
4 - Air pipe.	1.	Plastic tube.	3mm dia x 150mm long.

Tools: knife; file; tin snips; hammer; scotch tape; marker.

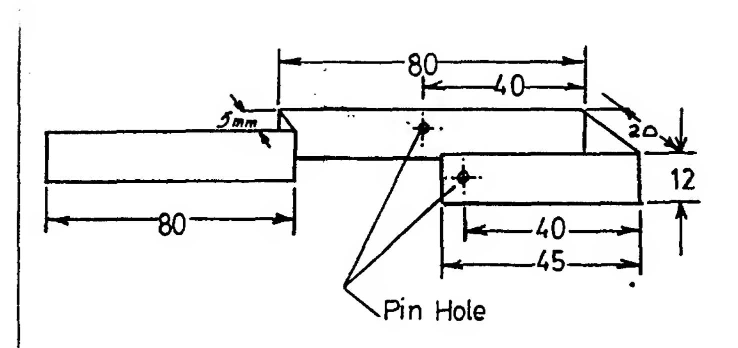
6- CONSTRUCTION DETAILS

Fig. 1.



Using a knife and a file cut out and shape a 40mm dia disc from a 15mm thick piece of styrofoam. Cut 8 matchsticks to a length of 20mm and insert these sticks to a depth of 5mm into the styrofoam as indicated in the sketch.

Fig. 2.



With the aid of the tin snips cut a 230mm x 12mm strip from the sheet of metal. Mark out the metal strip according to the dimensions given in the sketch. Using the hammer and a nail punch out the two holes for the axle. Bend the strip to make the shape of the holder as indicated.

Mount the wheel in the wheel holder and pass a nail through the holes and through the centre of the wheel. The wheel should be able to revolve freely on the axle.

To complete the assembly, scotch tape a 150mm length of 3mm dia. plastic tube onto the holder tangential to the spokes of the wheel, as indicated in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50.

8- METHOD OF USE

Blow air through the plastic tube, the wheel will rotate due to air pressure. This will show the concept of wind energy. Hold the wheel under a running tap as shown in Fig. A. The wheel will rotate due to the water. This will show the concept of water energy.

9- COMMENTS

1- ITEM

LOW COST SUBMARINE.

2- PURPOSE

To explain the principle of buoyancy and the submarine.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids.
National Educational Equipment Centre, Lahore 16, Pakistan

4- LINE DRAWING OF PROTOTYPE

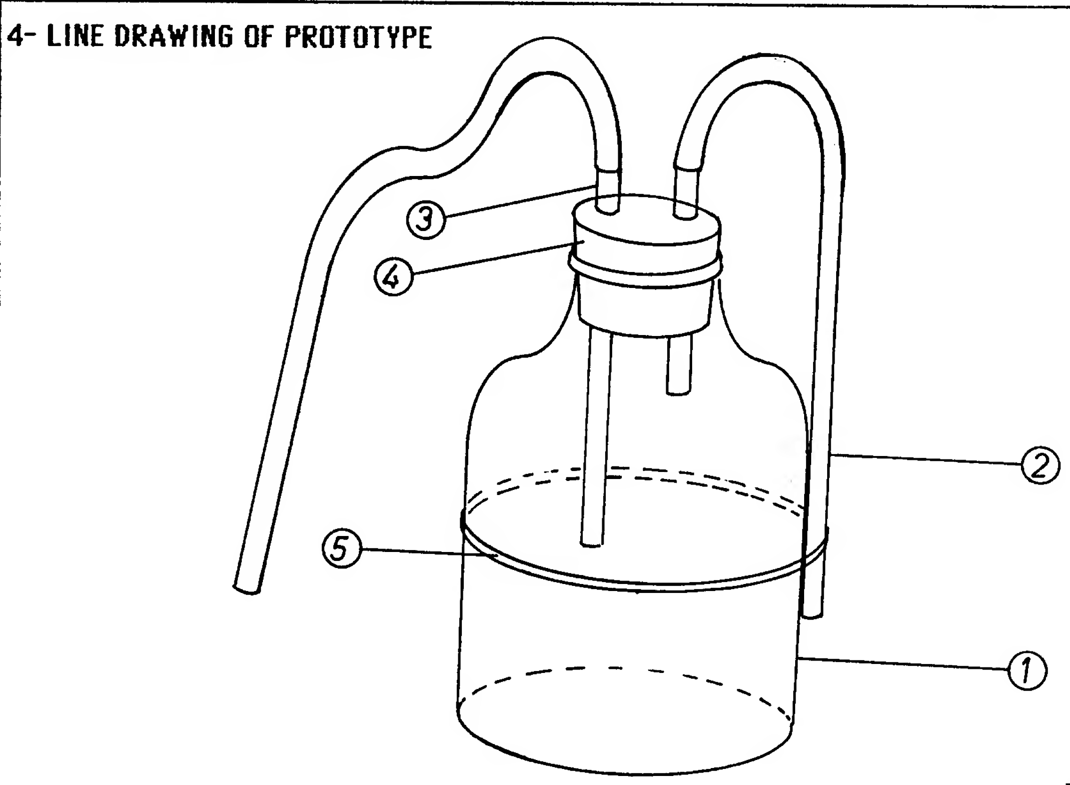


FIG. A.

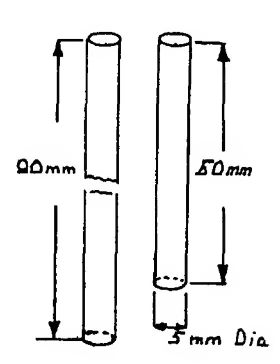
5- MATERIALS FOR CONSTRUCTION

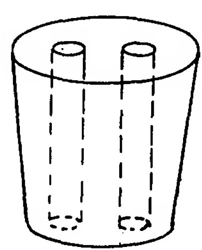
Components	Qty	Materials Required	Dimensions
1- Container.	1.	Glass bottle, wide mouthed	approx. 1 litre.
2- Tubes.	2.	Plastic tubing.	5mm dia x 350mm 5mm dia x 120mm
3- Tube.	2.	Glass tube.	5mm dia x 90mm 5mm dia x 50mm
4- Stopper.	1.	Cork stopper.	To suit bottle.
5- Rubber band.	2.	Rubber bands.	To suit bottle dia.

Tools: Cork borer; scissors.

6- CONSTRUCTION DETAILS

Fig. 1.





Select a cork stopper to fit the neck of the bottle. Using the cork borer, drill two holes of 5mm dia. as indicated in the sketch. Insert the two glass tubes into the holes.

To complete the assembly fix the plastic tubes onto the glass tubes, insert the stopper into the bottle, and strap one tube (the shorter one) to the side of the bottle using the rubber bands. (See Fig. A).

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.0.

8- METHOD OF USE

Put the apparatus in a bucket of water and suck the air through the longer piece of plastic tubing. Water will fill the bottle and as the weight of the bottle becomes heavier than the bouyant force of water the bottle will start to sink. Now blow air through the tube. Due to air pressure water will be forced out of the bottle which will then rise up to the surface again. This also explains the principle of the submarine.

9- COMMENTS

1- ITEM

CARTESIAN DIVER APPARATUS

2- PURPOSE

To demonstrate Boyle's Law and Archimede's Principle

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project
National Institute of Science and Technology, Manila, Philippines

4- LINE DRAWING OF PROTOTYPE

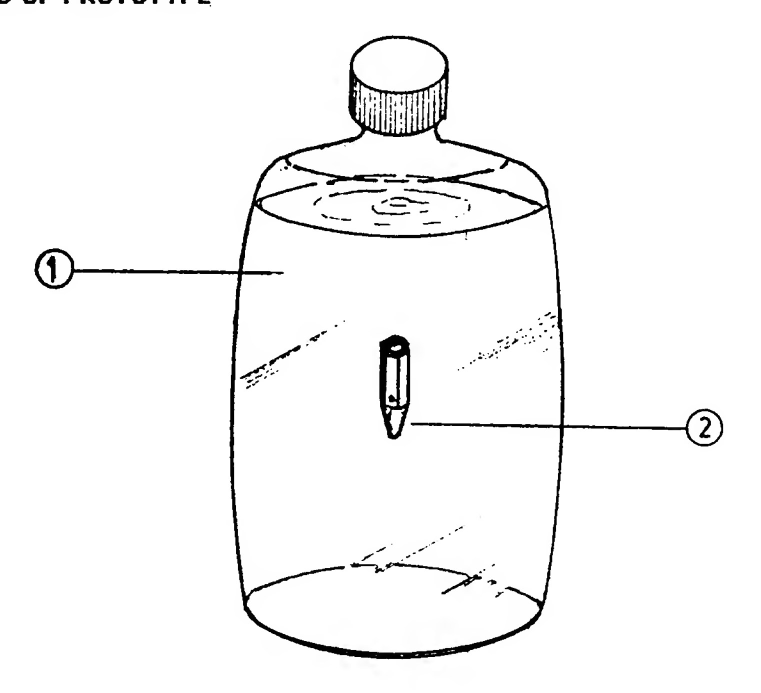


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Container.	1.	Transparent plastic bottle.	approx. 240mm high
2- Diver.	1.	Ball pen casing	---

6- CONSTRUCTION DETAILS

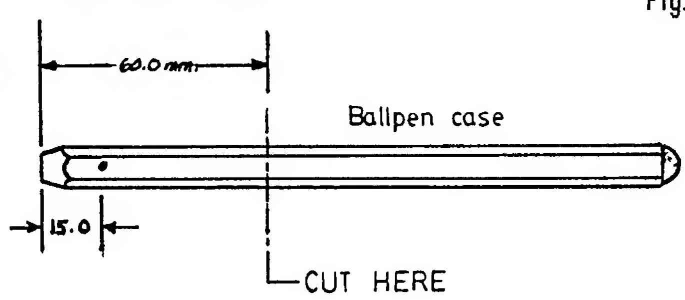


Fig. 1.

The diver can be made from a discarded ball pen. Cut the outer casing to the dimensions indicated in the sketch. Drill a small hole of approx. 1mm dia near the end of the case. Cut off the head of the pen from the ink holder.

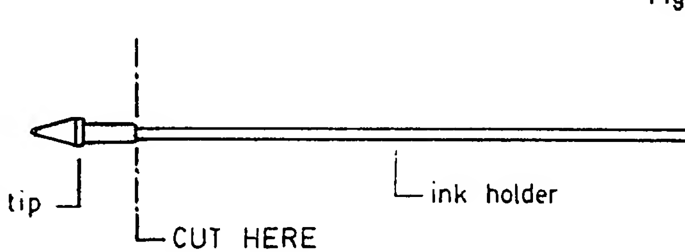
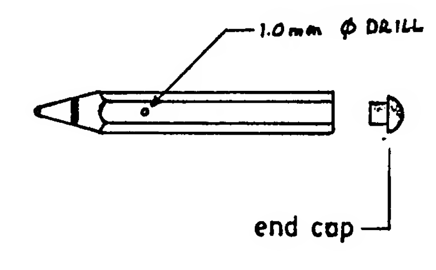


Fig. 2.

Insert the writing tip into the ball pen casing. Partially fill the casing with water and fit the end cab into the casing.
Note: The diver must barely float vertically when placed in water.



Place the diver inside the plastic bottle. Fill the plastic bottle with water leaving an air gap at the top. Place the diver inside the bottle tightly.
Note: Make sure that when the sides of the plastic bottles are pressed, no air escapes from the cap.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50.

8- METHOD OF USE

To operate press the sides of the plastic bottle.

9- COMMENTS

A clear ball pen casing is to be preferred so that the compression of air can be observed by the students.

1- ITEM

'U' TUBE - HARE'S APPARATUS.

2- PURPOSE

For comparing the densities of liquides.

3- INFORMATION SUBMITTED BY

Science Equipment Centre, Lagos, Nigeria.

4- LINE DRAWING OF PROTOTYPE

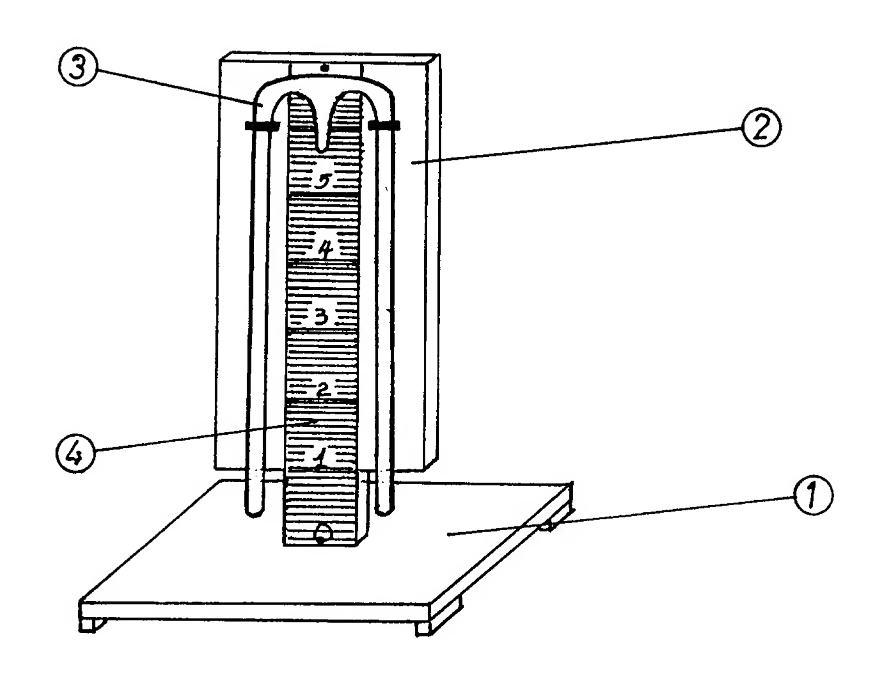


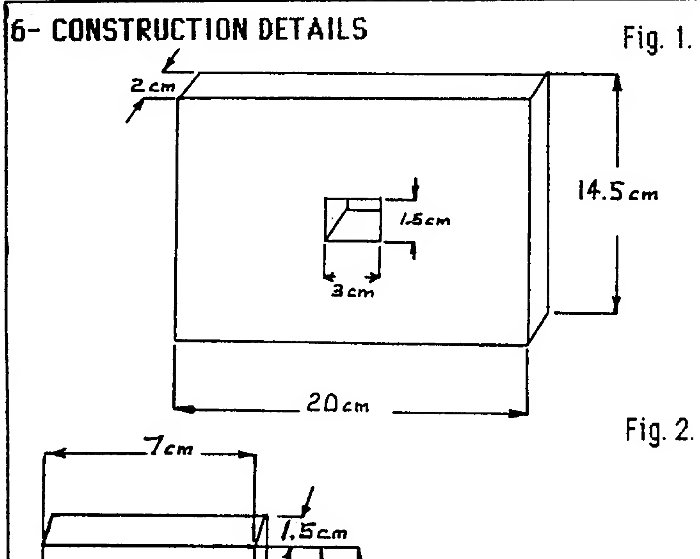
FIG . A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Baseboard.	1.	Wood.	20cm x 14.5cm x 2cm.
2 - Support.	1.	Wood.	52cm x 7cm x 1.5cm
3 - Three limbed glass 'U' tube.	1.	Glass.	49cm x 6cm wide
4 - Scale.	1.	Paper.	52cm x 4cm.
		Rubber tube.	
		Glue.	
		Polish.	

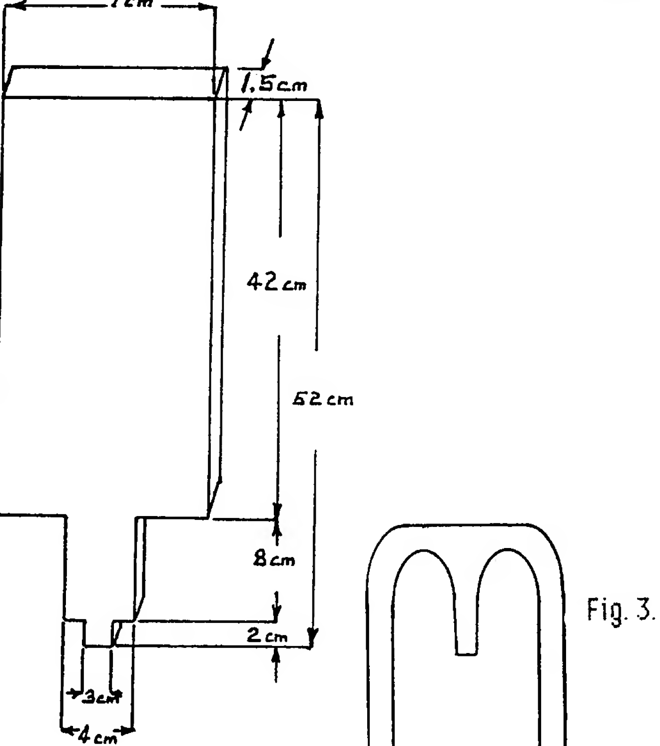
6- CONSTRUCTION DETAILS

Fig. 1.



Construct the wooden base of size 20cm x 14.5cm x 2cm thick. In the centre of the base chisel out a rectangular hole as indicated in the sketch. Smooth down all surfaces using sandpaper.
Fix four feet, each of approx. 4cm x 2cm x 1.5cm thick, to the underside corners of the baseboard.

Fig. 2.



From a piece of 1.5mm thick wood prepare the support according to the dimensions given in the sketch. Smooth down all surfaces using sand-paper.
Insert the support into the base and firmly fix using glue.
Using a piece of 4cm wide paper construct a scale and paste it to the support (mark in cm. and mm. with the zero at the bottom).

Fig. 3.

Construct, or obtain, a three limbed glass 'U' tube of approx. 52cm long and 6cm across the outer limbs.
Assemble the apparatus as shown in Fig. A. using small metal pipe clips to clamp the 'U' tube in place.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

8- METHOD OF USE

As for other designs of Hare's Apparatus.
Place the containers with the liquids to be compared on the baseboard such that the tubes are dipping into the liquids. Attach a piece of rubber tubing with a clip on it to the centre limb. Open the clip, suck up the liquids and close the clip. Take the necessary readings.

9- COMMENTS

The wood can be polished using a suitable varnish.

1- ITEM

'U' TUBE MANOMETER.

2- PURPOSE

For the measurement of gas pressure.

3- INFORMATION SUBMITTED BY

Science Equipment Centre, Lagos, Nigeria.

4- LINE DRAWING OF PROTOTYPE

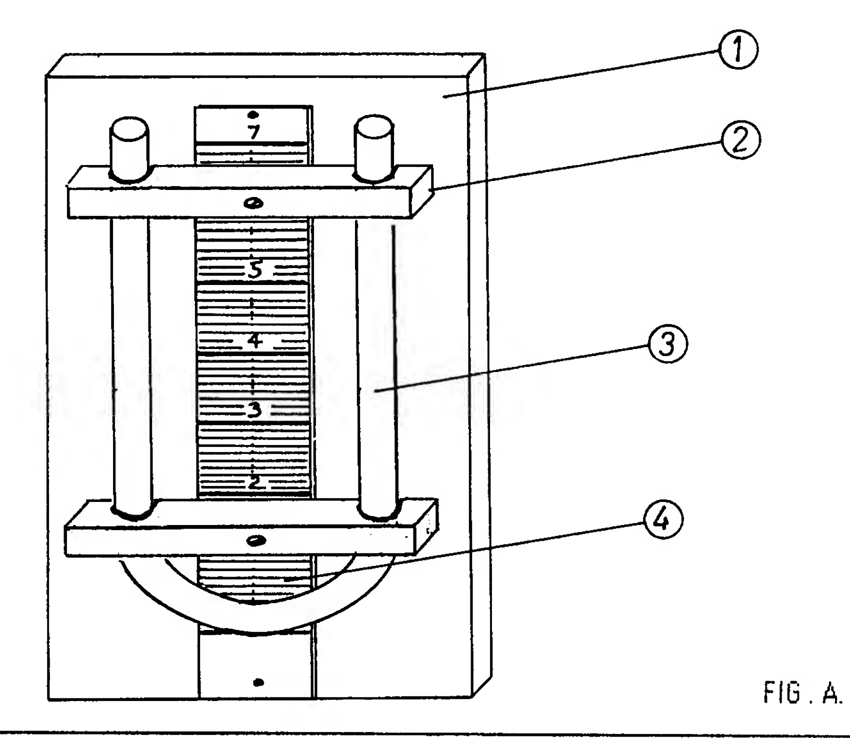


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Mounting panel.	1.	Plywood.	15cm x 7.5cm x 1.5cm
2 - Locking bars.	2.	Wood.	6cm x 2.0cm x 2.5cm.
3- 'U' tube.	1.	Glass.	approx. 12.5cm x 5cm wide.
4 - Scale.	4.	Paper.	14cm x 3cm.
	2.	Bolts with nuts.	3mm dia x 5cm long.
		Varnish.	

6- CONSTRUCTION DETAILS

Fig. 1.

Construct the wooden mounting panel and drill two holes of 3mm dia. as shown in the sketch (the distance apart of these two holes will depend upon the size of the 'U' tube to be used). Smooth down the panel using sandpaper, and varnish the panel.

Construct a scale from a 14cm x 3cm piece of paper and fix it centrally on the panel (mark in cm and mm with the zero at the bottom bend of the 'U' tube).

Fig. 2.

To make the locking bars take a piece of wood of size 6cm x 5cm x 2cm thick. Drill the holes as shown in the sketch. The distance marked 'L' will depend upon the width of the 'U' tube available. Saw the wood in half, lengthways, to make the two locking bars.

Fig. 3.

Construct, or obtain a suitable glass 'U' tube.

Assemble the apparatus as shown in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

8- METHOD OF USE

As for other 'U' tube manometers.

9- COMMENTS

1- ITEM

SIMPLE 'U' TUBE MANOMETER.

2- PURPOSE

Can be used for indicating air and water pressure during experiments.

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project.
National Institute of Science and Technology. Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

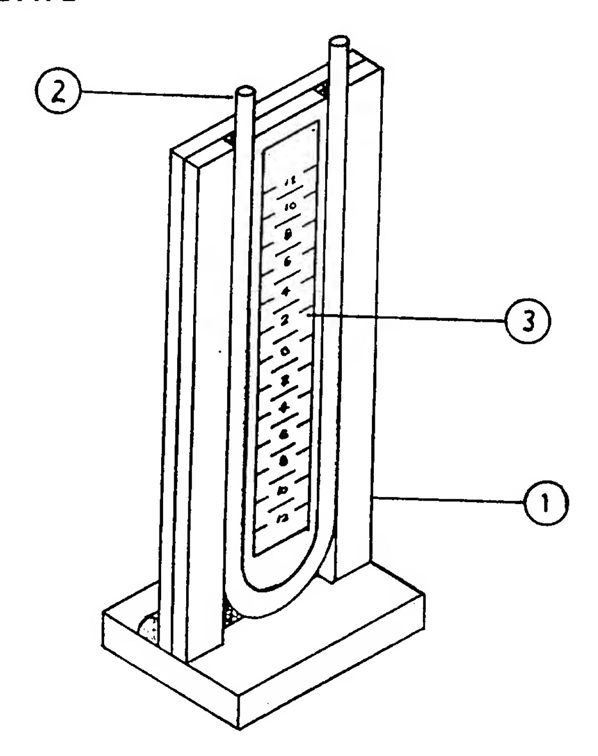
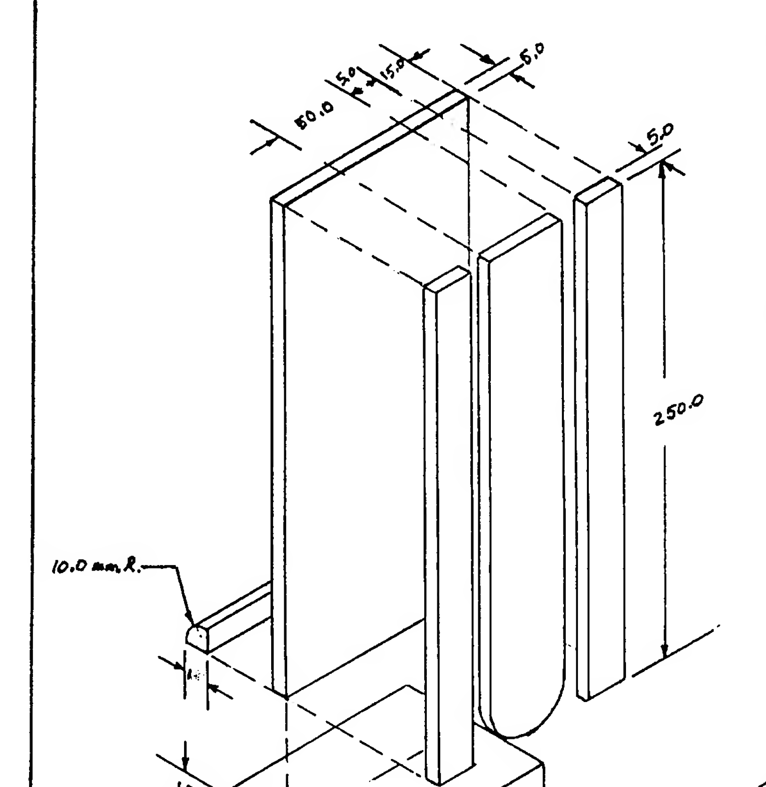


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Base/Stand.	1.	Wood.	Refer to details of construction.
2- 'U' tube manometer.	1.	Plastic tube.	5mm dia x 300mm.
3 - Scale card.	1.	White cardboard.	230mm x 50mm

6- CONSTRUCTION DETAILS



Prepare the wooden parts of the stand and base, as shown in the sketch, and assemble the stand and base using nails and glue.

Cut a piece of clear, flexible plastic tubing of 5mm dia. to a length of 300mm. Fix the plastic tubing into the slot of the stand using epoxy adhesive or rubber cement.

Prepare a scale card and paste it onto the front face of the stand.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.50.

8- METHOD OF USE

Place coloured water inside the tube (food colouring may be used). The water level should be to the zero mark on the scale card.

9- COMMENTS

1- ITEM

BIMETAL STRIP.

2- PURPOSE

To show that different metals have different expansion rates.

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project,
National Institute of Science and Technology, Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

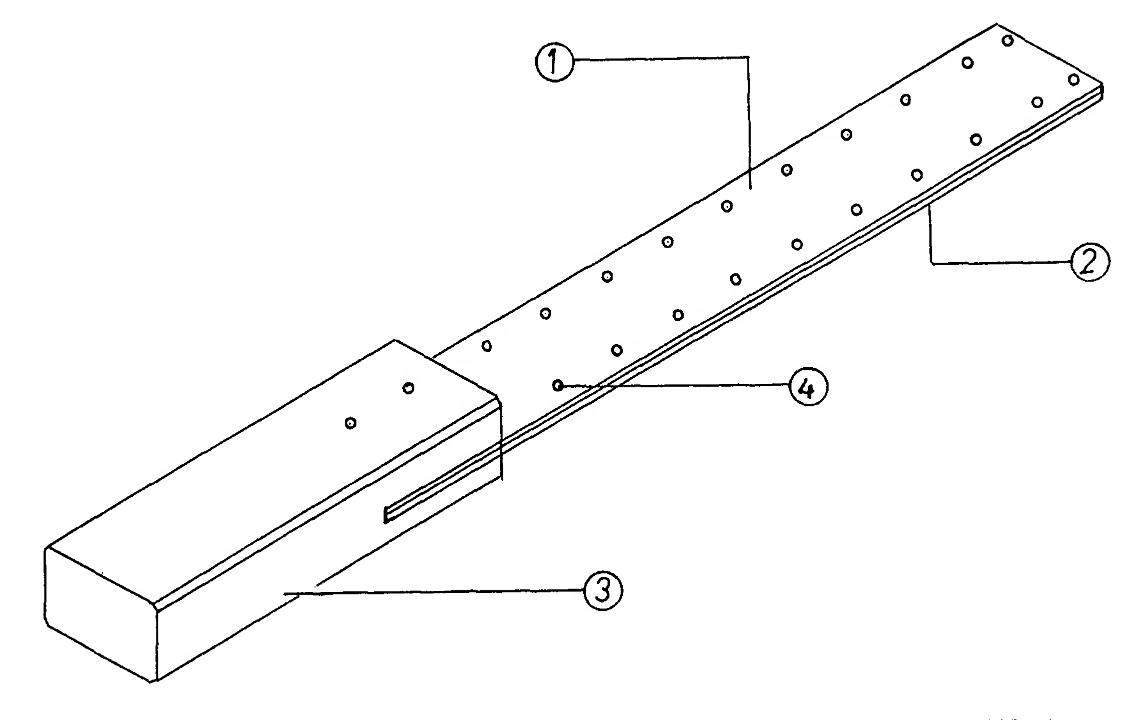


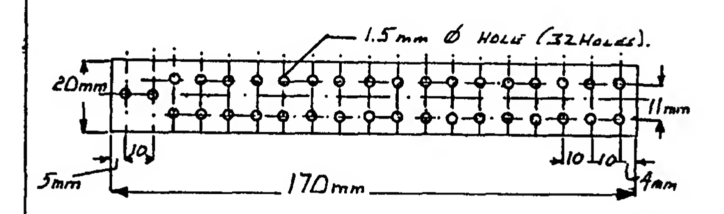
FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Metal A.	1.	Aluminium strip.	170mm x 20mm x 20 gauge.
2- Metal B.	1.	Crate band strip. (steel strip).	170mm x 20mm x 20 gauge.
3- Handle.	1.	Wood.	100mm x 20mm x 15mm
4- Rivets.	32.	Aluminium rivets or small nails.	1.5mm dia.

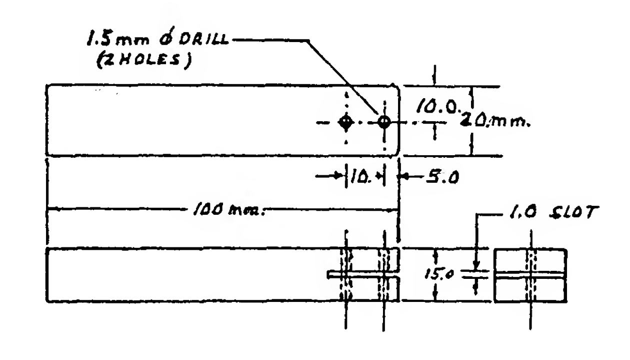
6- CONSTRUCTION DETAILS

Fig. 1.



Cut a suitable length off a crate band strap (steel). Cut a strip of the same length and width (170mm x 20mm) from an aluminium sheet. Clamp the two strips together and drill 1.5mm dia holes as indicated in the sketch. Rivet the strips together using aluminium rivets or nails.

Fig. 2.



Cut a piece of wood to the sizes indicated in the sketch. Saw a slot in one end, and drill the holes.

Push the laminated metal strips into the slot and rivet firmly in place as indicated in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$2.00.

8- METHOD OF USE

Heat the laminated metal strip over an alcohol burner and observe the bending of the strip. This indicates an unequal expansion of its metal components.

9- COMMENTS

Pass both sides of the metal strip over the burner when heating to avoid misinterpretation that the bending is due to unequal heating.

1- ITEM

EXPANSION APPARATUS.

2- PURPOSE

To demonstrate the completion of an electric circuit using the expansion of a rubber band with heat.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

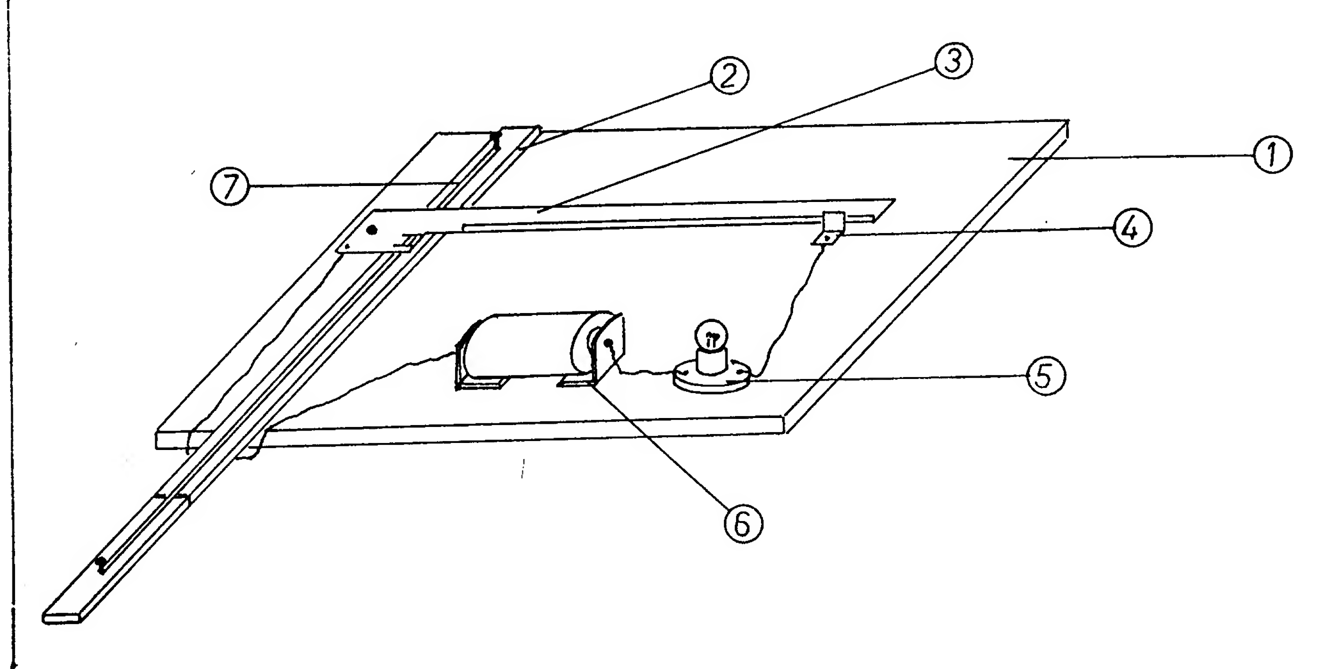


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Baseboard.	1.	Plywood.	150mm x 100mm x 10mm
2 - Support strip.	1.	Wood.	200mm x 15mm x 8mm
3 - Pointer.	1.	Thin tin or aluminium sheet.	140mm x 15mm
4 - Stop.	1.	Thin tin or aluminium sheet.	20mm x 8mm
5 - Light source.	1.	Bulb & bulb holder (1.5 volt).	
6 - Cell holder brackets.	2.	Tin or aluminium sheet.	50mm x 25mm
7 - Rubber band.	1.	Rubber band.	
		Connecting wire.	
		Nails.	

Tools: Woodsaw; hammer; tin snips.

6- CONSTRUCTION DETAILS

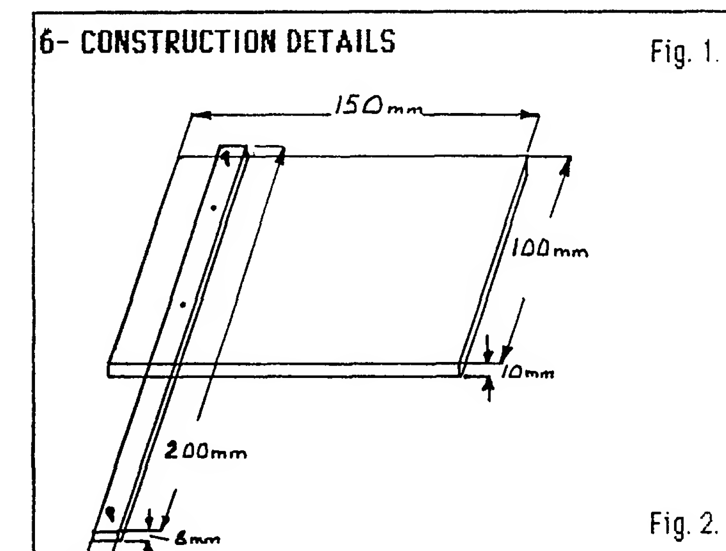


Fig. 1. Cut the wooden base to a size of 150mm x 100mm and cut the support strip to a size of 200mm x 115mm. Sandpaper both pieces to remove the rough edges. Nail the support strip to the base as indicated in the sketch. Firmly fix two nails in the strip over which the rubber band can be stretched.

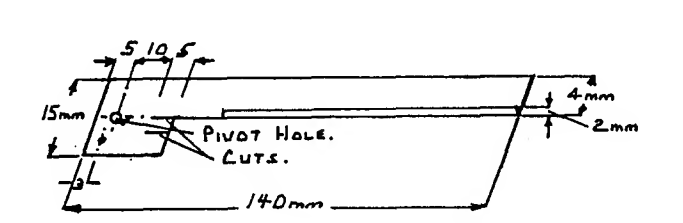


Fig. 2. From the metal sheet cut the pointer to the size indicated in the sketch. Make two cuts for a length of 5mm to take the rubber band. Using a nail, punch a hole for the pivot and a smaller hole in the corner to connect the wire. Bend up a length of the bottom edge for a height of 2mm.

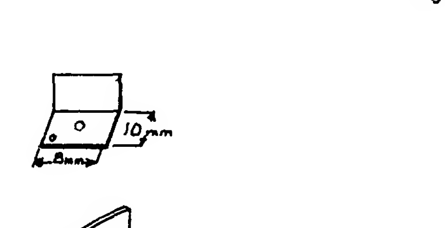


Fig. 3. From the metal sheet cut a piece of size 20mm x 8mm. Bend the 20mm length in half at right angles. Using a nail, punch a hole and a smaller hole in the corner to connect the wire.

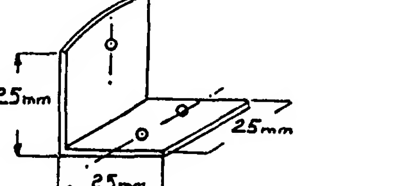


Fig. 4. From the metal sheet cut two pieces of size 50mm x 25mm. Bend the 50mm length in half at right angles. Using a nail, punch three holes as indicated in the sketch.

Assemble the apparatus as indicated in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.50.

8- METHOD OF USE

Wire up the electric circuit as indicated in Fig. A and adjust the pointer on the rubber band such that it is not in contact with the stop when the apparatus is in the vertical position.
Dip the support strip and rubber band into hot water up to the water level mark on the strip as shown in Fig.A. The rubber band will expand due to the heat which in turn will allow the pointer to touch the stop. The torch bulb will light due to the completion of the electric circuit which has been brought about by the expansion of the rubber band.

9- COMMENTS

1- ITEM

LINEAR EXPANSION OF WIRE APPARATUS.

2- PURPOSE

To show that wire expands, or elongates when heated.

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project,
National Institute of Science and Technology, Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

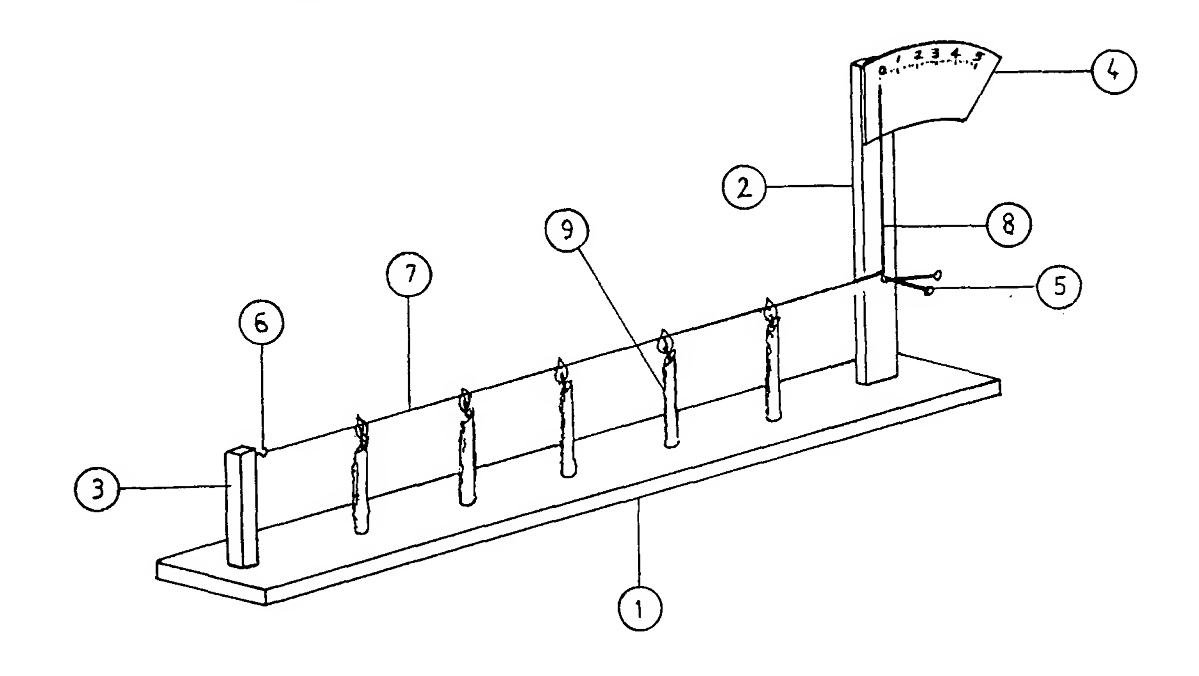


Fig. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Base.	1.	Plywood.	550mm x 100mm x 10mm
2 - Scale/Pointer support.	1.	Plywood.	490mm x 30mm x 10mm.
3 - Wire support.	1.	Wood.	130mm x 20mm x 20mm.
4 - Scale card.	1.	Cardboard.	approx. 400mm x 70mm.
5 - Pointer pivot.	1.	Nail.	approx. 38mm long.
6 - Hook.	1.	Screw hook.	12.7mm eye diameter.
7 - Specimen wire.	1.	Iron or copper wire.	24 gauge.
8 - Pointer.	1.	Galvanised iron wire.	12 gauge x approx 600mm
9 - Heat source.	5.	Candles.	approx. 100mm high.

6- CONSTRUCTION DETAILS

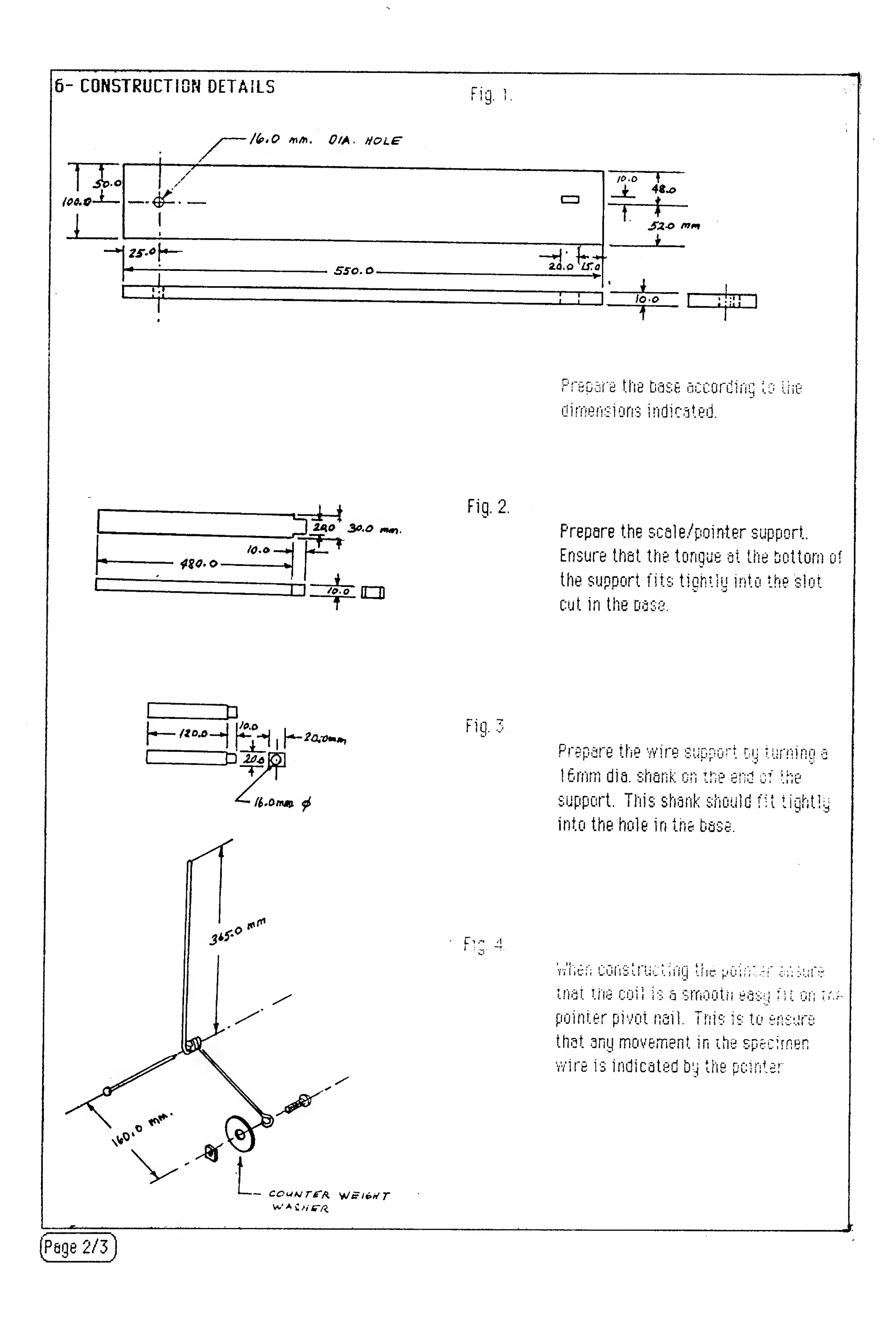


Fig. 1.

Prepare the base according to the dimensions indicated.

Fig. 2.

Prepare the scale/pointer support. Ensure that the tongue at the bottom of the support fits tightly into the slot cut in the base.

Fig. 3

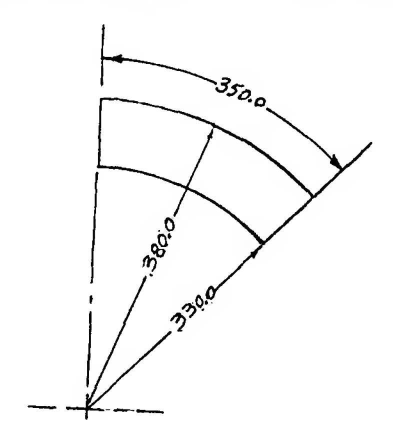
Prepare the wire support by turning a 16mm dia. shank on the end of the support. This shank should fit tightly into the hole in the base.

Fig. 4

When constructing the pointer ensure that the coil is a smooth easy fit on the pointer pivot nail. This is to ensure that any movement in the specimen wire is indicated by the pointer

6- CONSTRUCTION DETAILS (Continued)

Fig. 5.



Using a piece of stiff cardboard cut out the scale card according to the dimensions indicated. Mark an arbitrary scale on the card.

Assemble the components as indicated in Fig. A. using a wood glue to firmly fix the two supports. Screw the hook into the wire support and also locate the pointer with the pivot nail at approx. the same height as the hook. The counter weight should be on the opposite side to the specimen wire.

Bend and fix one end of the specimen wire around the pointer to a few mm. above the pivot. Insert the other end in the hook screw at the wire support. Adjust the wire on the hook so that the pointer is set vertical at the zero mark on the scale card. When correctly set at zero firmly fix the wire on the hook.

7- APPROXIMATE COST OF ONE ITEM (in US $)

$3.00.

8- METHOD OF USE

Light the candles under the specimen wire and observe the movement of the pointer showing that the wire elongates when heated.

9- COMMENTS

1- ITEM

EXPANSION APPARATUS.

2- PURPOSE

To show that metal expands when heated.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

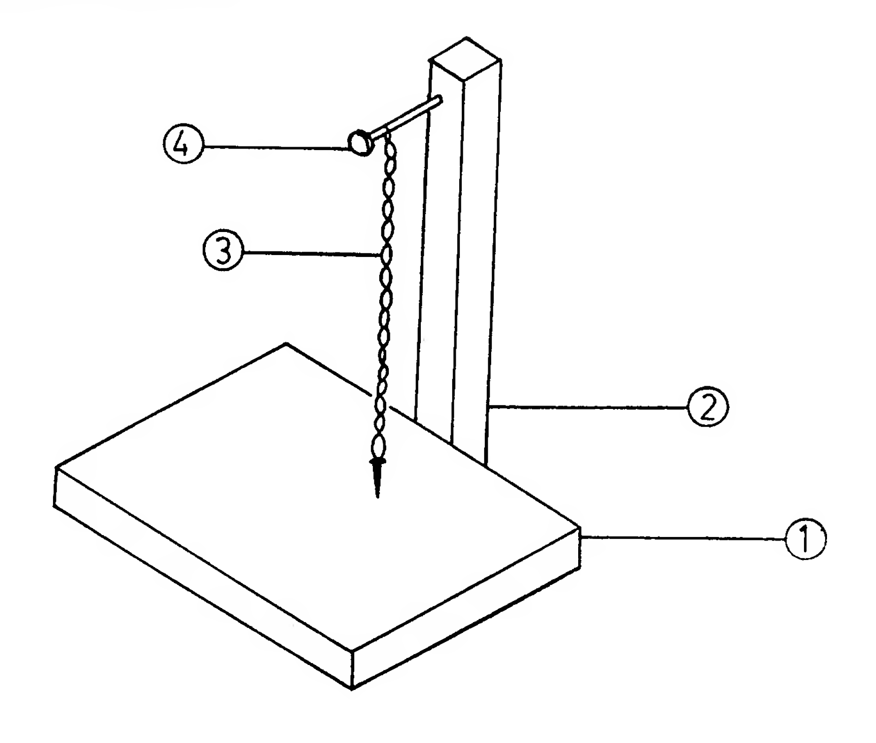


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Base.	1.	Wood.	60mm x 60mm x 5mm.
2 - Support.	1.	Wood.	140mm x 10mm x 10mm.
3 - Test piece.	1.	Metal wire (steel, copper or brass)	20 gauge.
4 - Hanger.	1.	Nail.	
		Spirit lamp.	

Tools: Woodsaw; plane; sandpaper; long nose pliers; side cutting pliers.

6- CONSTRUCTION DETAILS

Fig. 1.

60 60 5

Using the woodsaw cut a rectangular piece of wood to make the base as shown in the sketch.

Fig. 2.

140mm 10 10

Cut a second piece of wood to a size of 140mm x 10mm x 10mm to make the vertical support.

Finish the base and the support using the plane and sandpaper and fix the support to the base using the hammer and nails.

Fig. 3.

Make a chain from the 20 gauge wire. In order to make the links of the chain cut 8mm long wire pieces with the help of the side cutting pliers. Using the long nosed pliers bend these lengths to form the links and join them to form the chain as shown in the sketch. Place a nail in the bottom link and close the link to hold the nail firmly.

Hang the chain from the nail fixed at the top end of the support as indicated in Fig. A. The nail at the end of the chain should swing freely just above the baseboard.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50.

8- METHOD OF USE

Heat the chain with the help of the spirit lamp. The chain will expand and the suspended nail at the lower end of the chain will touch the baseboard, which will indicate that expansion of the chain has taken place. This will show that matter expands when heated.

9- COMMENTS

1- ITEM

APPARATUS FOR THE EXPANSION OF LIQUIDS

2- PURPOSE

To demonstrate that liquids expand when heated.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids
National Educational Equipment Centre, Lahore 16, Pakistan

4- LINE DRAWING OF PROTOTYPE



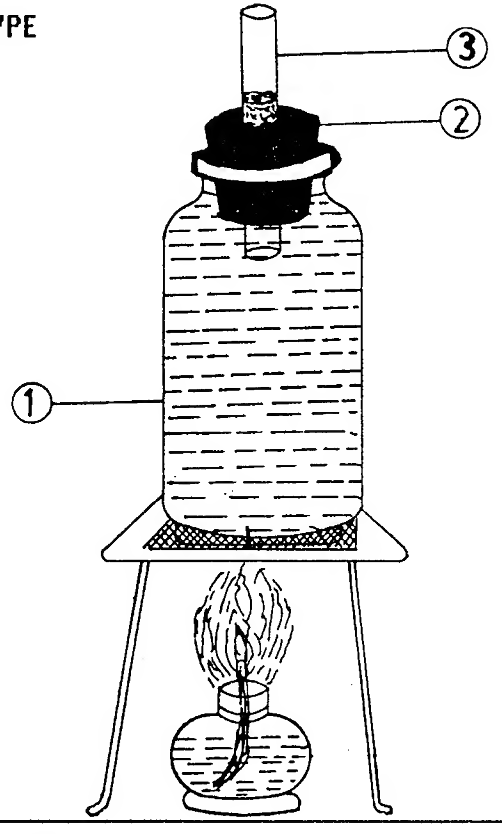


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Container	1.	Glass Bottle.	as available.
2- Stopper	1.	Rubber stopper.	to suit bottle.
3- Tube	1.	Glass or plastic tube.	5mm dia x 80mm long.
	1.	Tripod stand.	
	1.	Spirit lamp.	
	1.	Coloured water.	
	1.	Cork borer.	
	1.	Wire gauze for tripod.	

6- CONSTRUCTION DETAILS

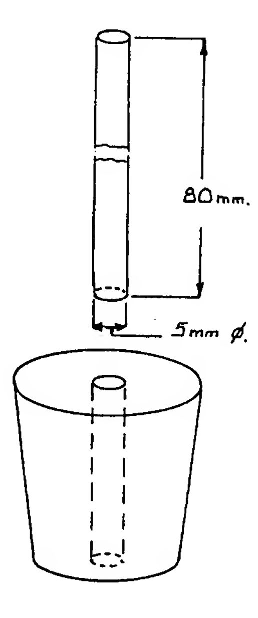


Fig. 1. Cut the glass (or plastic) tube of 55mm diameter, to a length of approx. 80mm. (Glass tubing can be cut by scoring a line around the glass with a file and then touch the line with a hot piece of metal). Using the cork borer drill a 5mm diameter hole in the stopper and then insert the tube into the stopper, as indicated in the sketch

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.5

8- METHOD OF USE

Completely fill the bottle with the coloured water. Insert the stopper into the bottle such that some water is expelled, so that there is no air in the bottle. Adjust the water level in the tube so that it is clearly seen above the level of the stopper. Mark the tube for the level of water. Place the bottle on a tripod, using a wire gauze, and gently apply heat to the bottle. The water in the tube will be seen to rise due to the expansion of liquid with heat.

9- COMMENTS

Caution: Stand the bottle on a wire gauze on the tripod and gently apply the heat.This is to avoid cracking the bottle if direct heat is applied.

1- ITEM

STEAM TURBINE APPARATUS.

2- PURPOSE

To demonstrate the working of a steam turbine.

3- INFORMATION SUBMITTED BY

The Institute for the Promotion of Teaching Science and Technology (IPST), Bangkok, Thailand.

4- LINE DRAWING OF PROTOTYPE

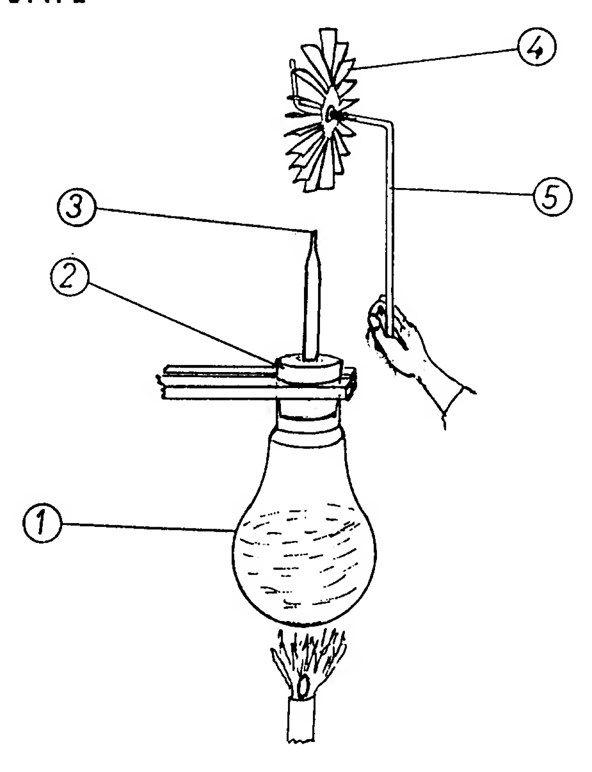


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Boiler.	1.	Used light bulb.	---
2 - Stopper.	1.	Rubber stopper with one hole.	To fit into neck of light bulb.
3 - Jet pipe.	1.	Glass tube.	approx. 6mm dia.
4 - Rotor.	1.	Aluminium sheet.	approx. 0.2mm thick.
5 - Rotor spindle.	1.	Metal rod.	2mm diameter.
	1.	Electric socket.	

6- CONSTRUCTION DETAILS

60mm Dia

Fig. 1. To construct the rotor mark out a 60mm diameter circle on the aluminium sheet. Divide this circle into 18 segments and cut along the lines as indicated in the sketch. Drill a hole in the centre of the disc to take the electric socket (axle).

Fig. 2. Using an electric socket, as indicated in 2.a., complete the rotor by inserting the socket

a. into the central hole and tighten the nuts on either side of the rotor. Using a pair of long nose pliers bend the segments of the rotor to form the shape indicated in sketch 2.b.

b. Using a piece of metal rod (preferably non-rusting) of suitable size, insert the rod into the axle and bend to the shape indicated in 2.b.

Obtain a used light bulb and carefully remove the metal cap and the internal components. Also obtain (or make) a single hole rubber stopper which will just form a tight fit in the light bulb.

Fig. 3. To form the jet draw out a piece of glass tubing as indicated in the sketch. Insert this tube into the stopper and then assemble the apparatus as indicated in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.00

8- METHOD OF USE

Fill the light bulb with water and insert the stopper, with jet fitted, into the bulb. Gently heat the water until steam is issuing from the jet. Holding the handle end of the spindle bring the rotor into the jet of steam and observe that the rotor will rotate.

9- COMMENTS

1- ITEM

STEAM TURBINE.

2- PURPOSE

To show the conversion of heat energy into mechanical energy.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

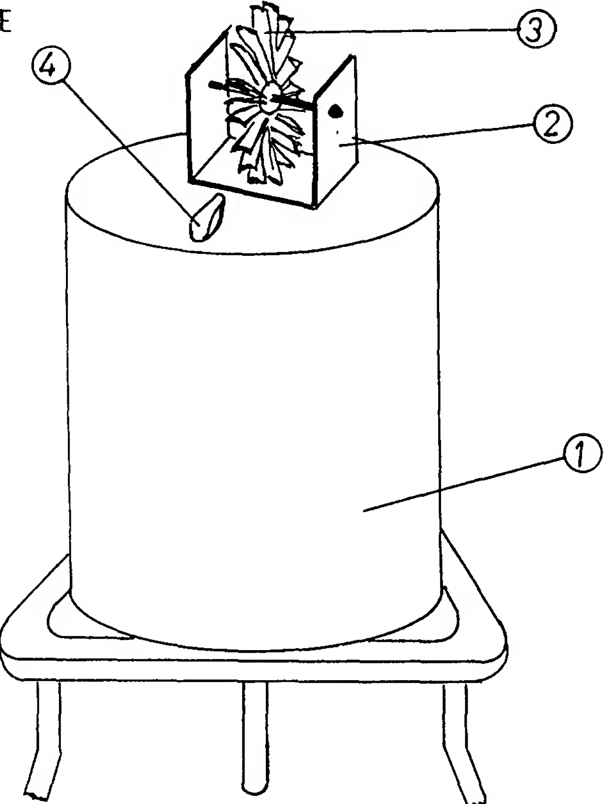


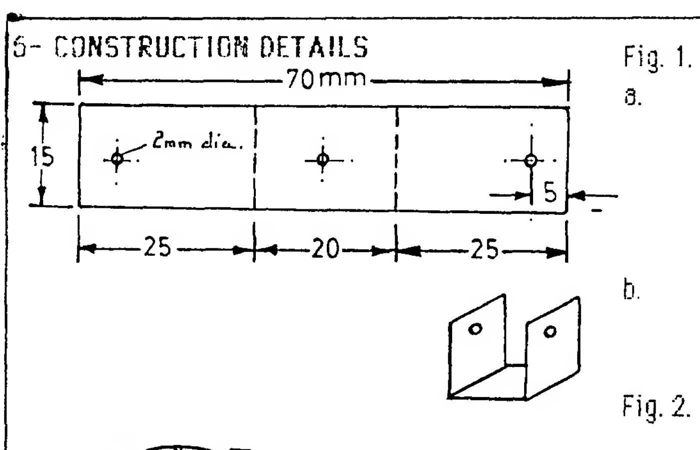
FIG . A.

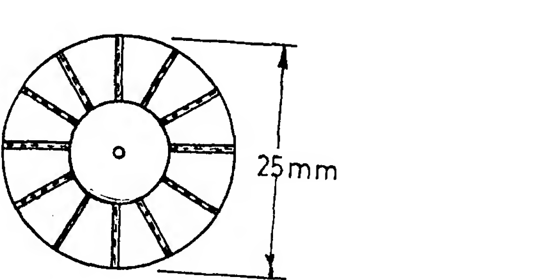
5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Container.	1.	Tin can.	approx. 60mm dia.
2 - Rotor support.	1.	Tin sheet.	70mm x 15mm x 1mm thick.
3 - Rotor.	1.	Aluminium sheet.	25mm dia. x gauge.
4 - Jet.	1.	Tin sheet or tube.	1mm bore dia.x 10mm long
	1.	Nail.	2mm dia. x 30mm long.
	1.	Small bolt with nut.	

Tools: tin snips; pliers; bradawl; tripod stand.

6- CONSTRUCTION DETAILS





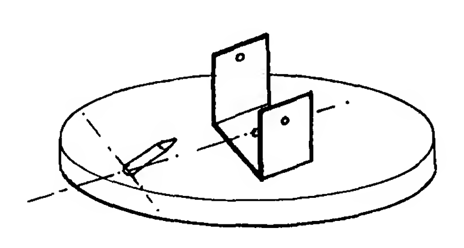


Fig. 1.

a. Using a piece of tin sheet mark out a strip of 70mm x 15mm wide, to form the rotor support. Complete the marking out as indicated in sketch 1.a. and, with the help of a bradawl or nail, make three holes. Cut the strip out and bend along the dotted lines to

b. form the shape shown in 1.b.

Fig. 2. From a thin piece of aluminium sheet cut a disc of 25mm dia. Mark out the disc as indicated in the sketch and cut along the dotted lines as shown. Using a pair of pliers twist each segment at right angles to form the shape shown in Fig. A. Using a bradawl or nail make a hole in the centre of the rotor.

Fig. 3. Obtain a small tin can of approx. 60mm dia. with a lid. Make a small hole to take the bolt in the centre of the lid and, using the nut and bolt, fix the rotor support to the lid. Make a second small hole for the jet at right angles to the support and at a suitable distance from it, as shown in the sketch.
Obtain a small dia. piece of metal tube and squeeze one end to form a jet. Insert the other end into the hole in the lid, and adjust the angle so that the tube is pointing towards the rotor (the tube should be fixed in place with a suitable heatproof adhesive).
Alternatively a jet could be constructed from tin sheet. Complete the assembly as indicated in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.00

8- METHOD OF USE

Put some water in the can until it is approximately two-thirds full. Place the lid assembly on the can and stand the can on a tripod. Heat the water using a spirit lamp. Steam will issue out from the jet and will cause the rotor to rotate.
This is the principle of the steam turbine and it shows that heat energy can be converted into mechanical energy.

9- COMMENTS

1- ITEM

ROTATING VANE APPARATUS.

2- PURPOSE

To demonstrate the effect of convection currents in air.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

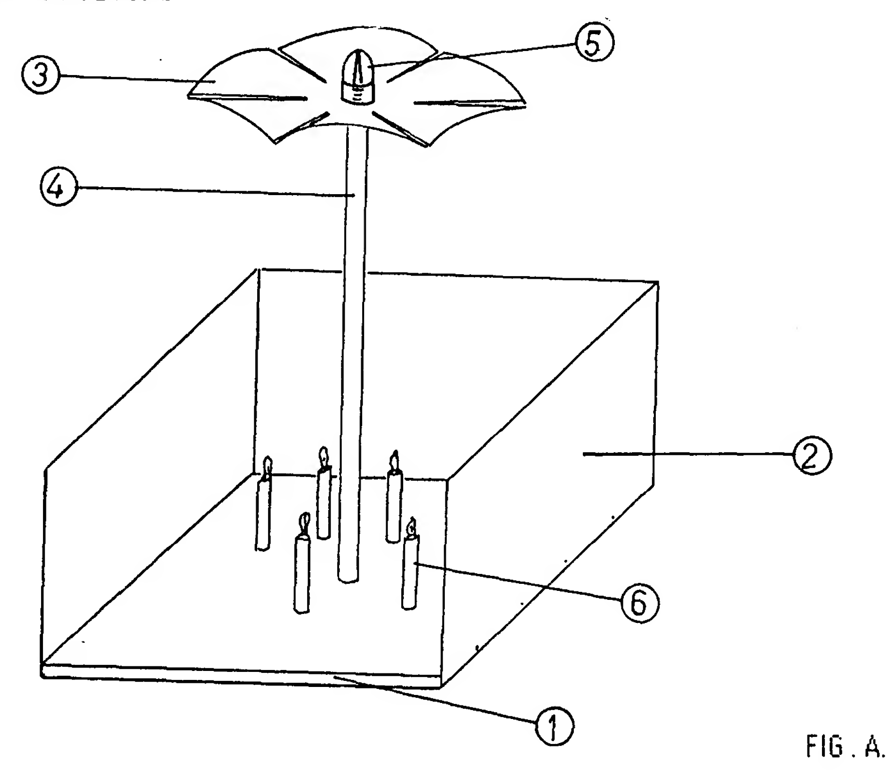


FIG . A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Baseboard.	1.	Wood.	100mm x 100mm X 8mm.
2 - Shield.	1.	Cardboard.	300mm x 100mm.
3 - Rotating Vane.	1.	Cardboard.	150mm dia.
4 - Support rod.	1.	Metal rod or pencil.	approx 3mm dia. x 130mm.
5 - Bearing.	1.	Fused torch bulb.	
6 - Heat source.	5.	Candles.	
		Drawing pins.	

Tools: Woodsaw; hammer; bench grinder; scissors.

6- CONSTRUCTION DETAILS

Fig. 1.

FOLD

100mm

100mm

100mm

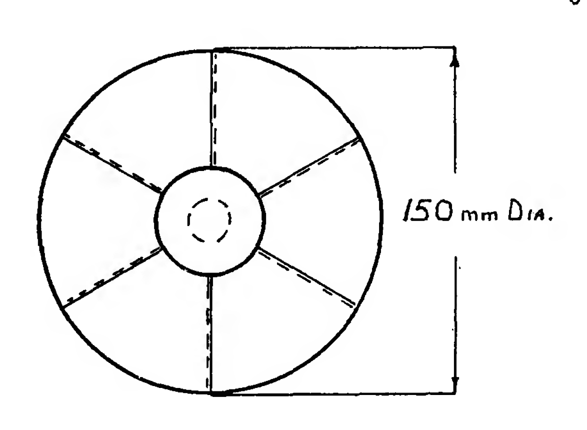
300mm

Using the woodsaw prepare a wooden base of size 100mm x 100mm x 8mm thick.

Prepare the support rod by taking a piece of metal of approx. 3 to 5mm dia. x 130mm long and grinding one end to a sharp point to act as the pivot for the vane. Fix the support rod in the centre of the base.

Cut a piece of stiff cardboard to the size of 300mm x 100mm and fold the cardboard to act as a shield around three sides of the base. Using the drawing pins, fit this shield to the base.

Fig. 2.



Using the scissors cut a 150mm dia. circle from a piece of stiff cardboard. Mark out the circle as indicated in the sketch and cut along the dotted lines. Slightly bend each segment to a concave shape. Remove the filament from a fused torch bulb and fix the bulb in the centre of the vane.

To complete the assembly place the vane onto the rod and ensure that it can rotate freely. Arrange the five candles on the base around the rod.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50.

8- METHOD OF USE

When the candles are lit, as shown in Fig. A., the air in the vicinity of the candles is heated and, being lighter, rises and causes the cold air to move out and sink. This movement causes the vane to rotate, and indicates the flow of convection currents from the candles in an upward direction.

9- COMMENTS

A torch bulb of the elongated type may provide a more successful bearing than the circular type.

1- ITEM

'WHAT CAUSES WIND' APPARATUS.

2- PURPOSE

To teach the concept of movement of air.

3- INFORMATION SUBMITTED BY

Institute for the Promotion of Teaching Science and Technology (IPST)
Bangkok, Thailand.



4- LINE DRAWING OF PROTOTYPE

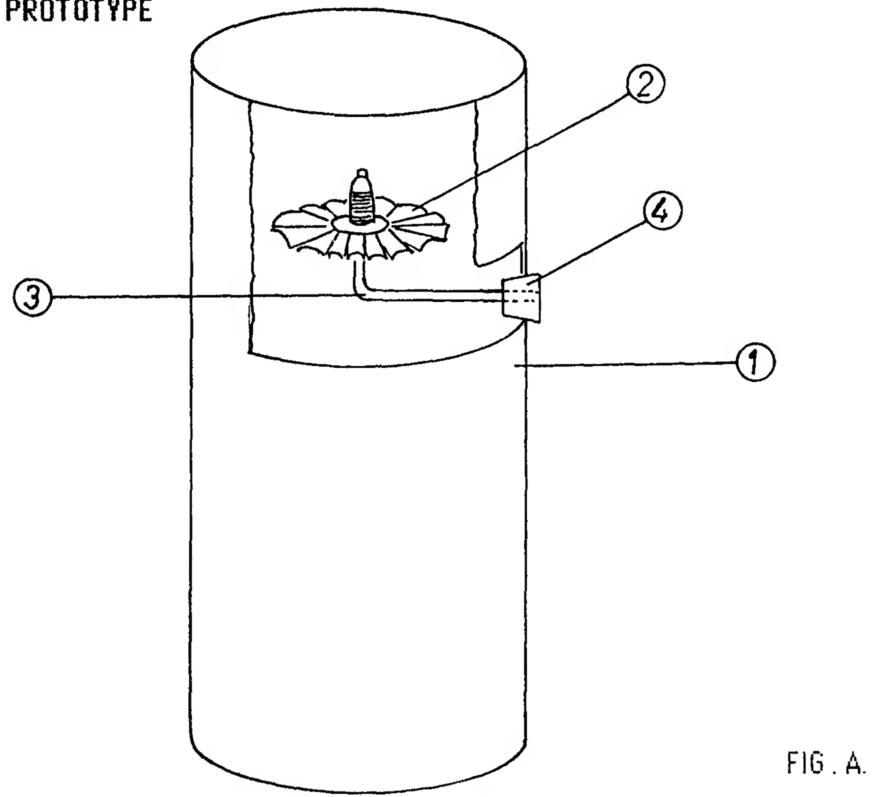


FIG . A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Container.	1.	Metal can.	75mm dia. x 200mm high.
2 - Propeller.	1.	Aluminium sheet.	60mm dia. x 0.2mm thick.
3 - Spindle.	1.	Metal wire.	2mm dia.
4 - Stopper.	1.	Cork stopper.	as available.
	1.	Electric socket.	

6- CONSTRUCTION DETAILS

Obtain a tin of approximately 75mm dia. x 200mm high. Remove the ends to form an open cylinder. At approx. 50mm from one end drill a hole in the cylinder to take the size of cork available.

60mm Dia

Fig. 1. Using a piece of 2mm thick aluminium sheet mark out the propeller as shown in the sketch. Cut along the dotted lines to form the vanes and then slightly twist each vane as shown in Fig. A.

Fig. 2. Obtain an electrical socket of the type indicated in the sketch 2.a. Remove one of the nuts and push the socket upwards through a hole in the centre of the propeller. Replace

a. the nut.

Grind a point on the end of a piece of 2mm dia. metal wire and bend the wire at a suitable distance such that the propeller is located centrally inside the container. The complete

b. propeller and axis assembly is as shown in Fig. 2.b.

Assemble the apparatus as shown in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.00.

8- METHOD OF USE

Set the apparatus over a flame from an alcohol lamp or candles, and observe what happens. The students should observe that the propeller rotates.

9- COMMENTS

1- ITEM

HEAT ABSORPTION APPARATUS.

2- PURPOSE

To show that dark coloured surfaces absorb more heat than light coloured surfaces.

3- INFORMATION SUBMITTED BY

School Science Equipment Develpment Project,
National Institute of Science and Technology. Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

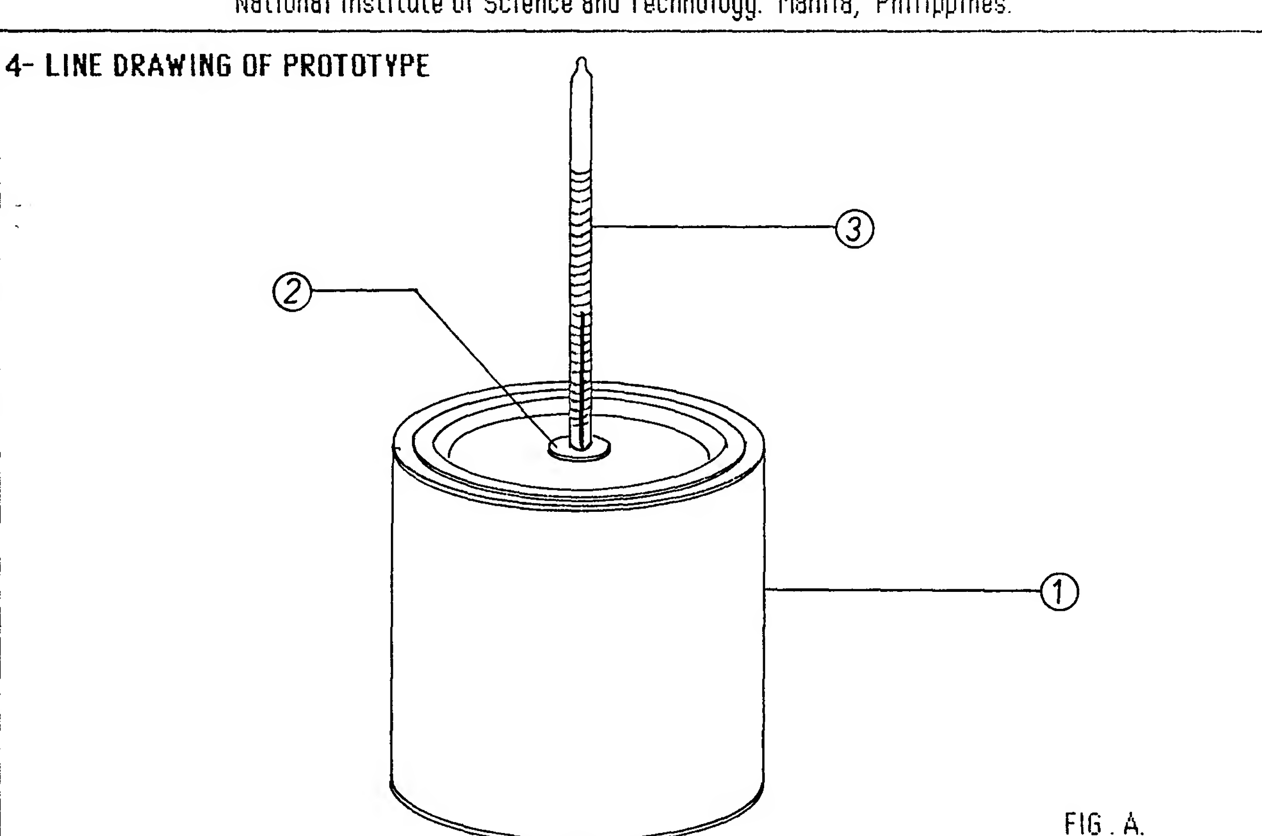


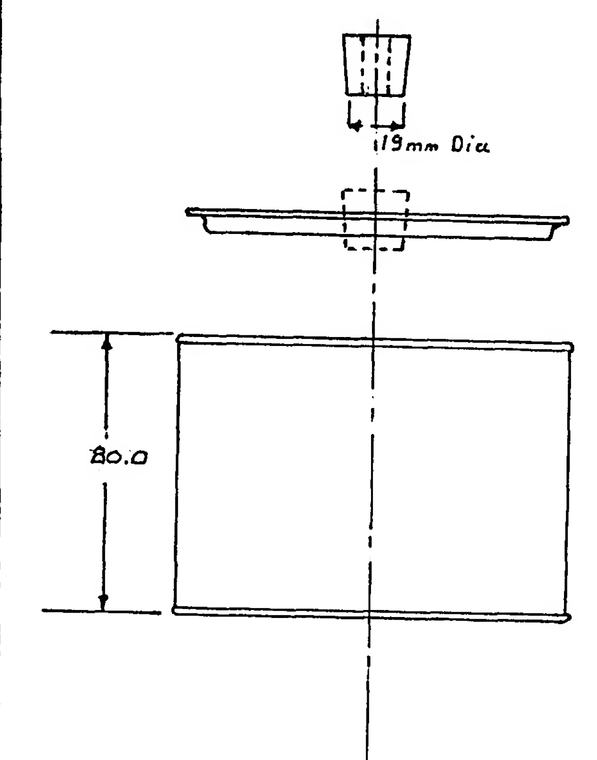
FIG . A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Container.	2.	Identical tin cans with lids.	approx. 100mm dia x 80mm.
2- Thermometer holder.	2.	Rubber stopper.	approx. 19mm bottom dia x 22.5mm top dia
3- Thermometer.	2.	Thermometer -10°C to 110°C	6.0mm dia x 300mm.

6- CONSTRUCTION DETAILS

Fig. 1.



Drill a 6.0mm dia. hole in the rubber stopper to accommodate the thermometer.

Drill a 19.0mm dia hole in the lid of the cans to accommodate the rubber stopper and thermometer. Paint one of the cans black and the other identical can white.

For easier assembly, first insert the thermometer into the stopper and then the stopper into the hole in the lid of the can. Then place the lid onto the can.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.50. without the thermometer.

8- METHOD OF USE

Expose both cans (one painted black and the other painted white) for 15 minutes or more to sunlight or an incandescent lamp. The difference in the readings of the thermometers indicates which can absorb most heat.

9- COMMENTS

When using an incandescent lamp, arrange the cans so that they are equidistant from the lamp.

1- ITEM

HEAT CONDUCTIVITY APPARATUS.

2- PURPOSE

To teach the concept of differences in heat conduction through various materials.

3- INFORMATION SUBMITTED BY

The Institute for the Promotion of Teaching Science and Technology (IPST), Bangkok, Thailand.

4- LINE DRAWING OF PROTOTYPE

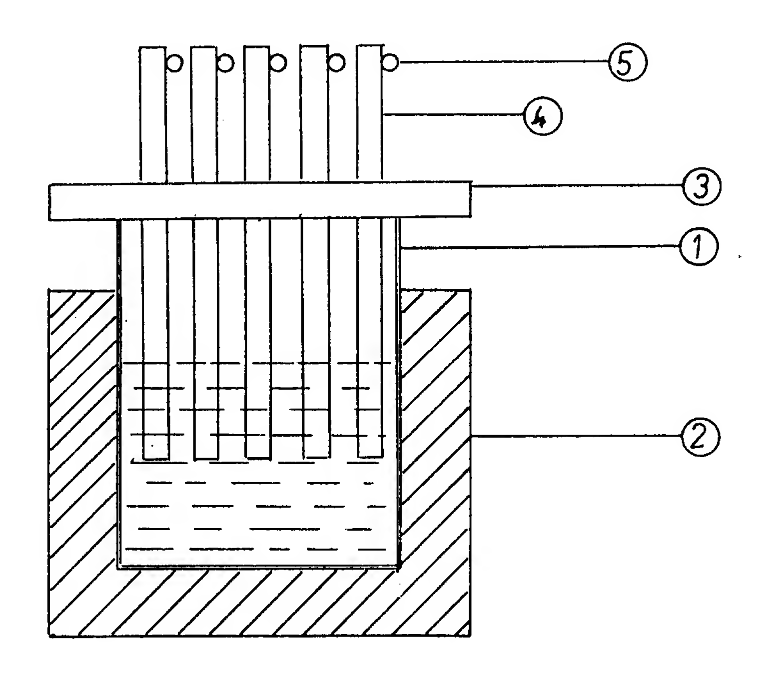


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Container.	1.	Glass bottle or tin can.	approx. 80mm dia x 100mm.
2- Insulator.	1.	Styrofoam.	approx. 100mm dia x 90mm.
3-Support strip.	1.	Wood.	100mm x 20mm x 10mm.
4- Test rods.	5.	Aluminium, brass, glass, plastic,wood, iron.	approx. 5mm dia x 120mm.
5- Indicator ball.	5.	Wax or plasticene.	

6- CONSTRUCTION DETAILS

Fig. 1.

Cut a glass bottle or tin can to the required size.

Fig. 2.

Prepare a wooden strip to act as a support for the test specimens. Drill five 5mm dia holes equidistant apart. The test rods should be a tight fit into these holes.

Fig. 3.

Construct the insulator for the container. If a single piece of the required size is not available, thinner pieces can be stuck together to form the required shape and size as indicated in the sketch. Use a suitable styrofoam adhesive for this purpose.

Assemble the apparatus as indicated in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50

8- METHOD OF USE

Pour hot water into the container and insert the rods. Observe that the wax (or plasticine) which is attached to the best heat conductor (test rod) will melt and fall down first.

9- COMMENTS

1- ITEM

APPARATUS FOR HEAT CONDUCTIVITY OF METALS

2- PURPOSE

To show that different metals have different heat conductivy.

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project,
National Institute of Science and Technology, Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

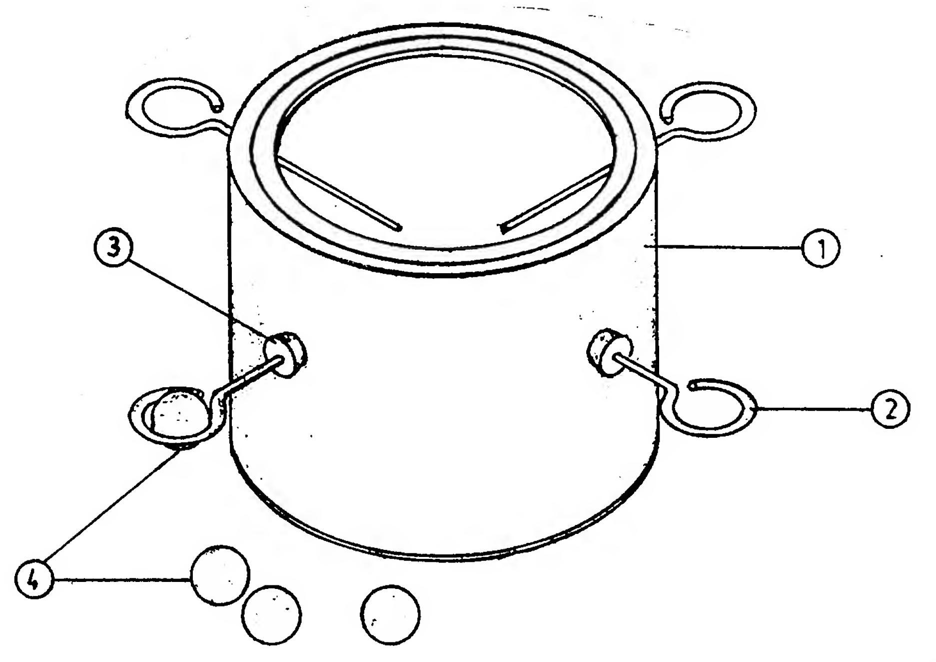


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Container.	1.	Tin can.	approx. 100mm dia x 70mm
2- Metal wire specimens.	4.	One each of copper, brass, steel, aluminium.	3mm dia x 160mm long.
3- Specimen holders.	4.	Rubber stoppers.	qpprox. 10mm bottom dia.
4- Marble.	4.	Glass marble.	approx. 15.5mm dia.

6- CONSTRUCTION DETAILS

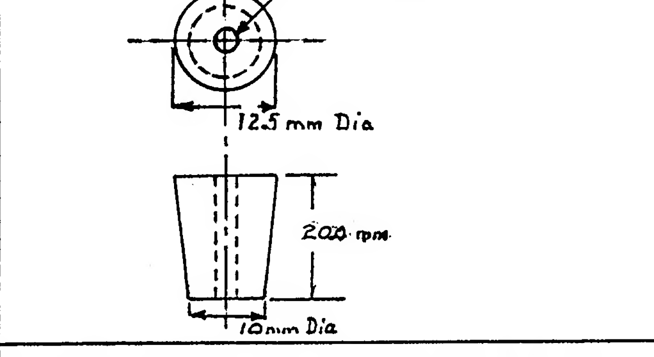
Fig. 1.

Take the tin can and drill four holes as indicated in the sketch. The diameter of the holes should allow the rubber stopper to enter. (Hole size should be the bottom diameter of the stopper used).

Fig. 2.

Construct the four specimen rods as indicated in the sketch. The inside diameter of the loop will depend upon the marbles available. The loop should be just large enough to let the marble pass through.

Fig. 3.



Drill a hole through the rubber stopper the same diameter as the specimen rods.

Assembly the apparatus as indicated in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$2.0.

8- METHOD OF USE

Coat the wire loops with wax by dipping into molten paraffin wax. Place a marble on each loop. Pour boiling water into the can (avoid pouring directly onto the rods), completely submerging the exposed rods inside the can. After a while it will be observed that the marbles resting on the loops will fall one at a time, indicating which metals conduct heat better.

9- COMMENTS

1- ITEM

SIMPLE CALORIMETER.

2- PURPOSE

For the determination of the specific heat of metals.

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project,
National Institute of Science and Technology, Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

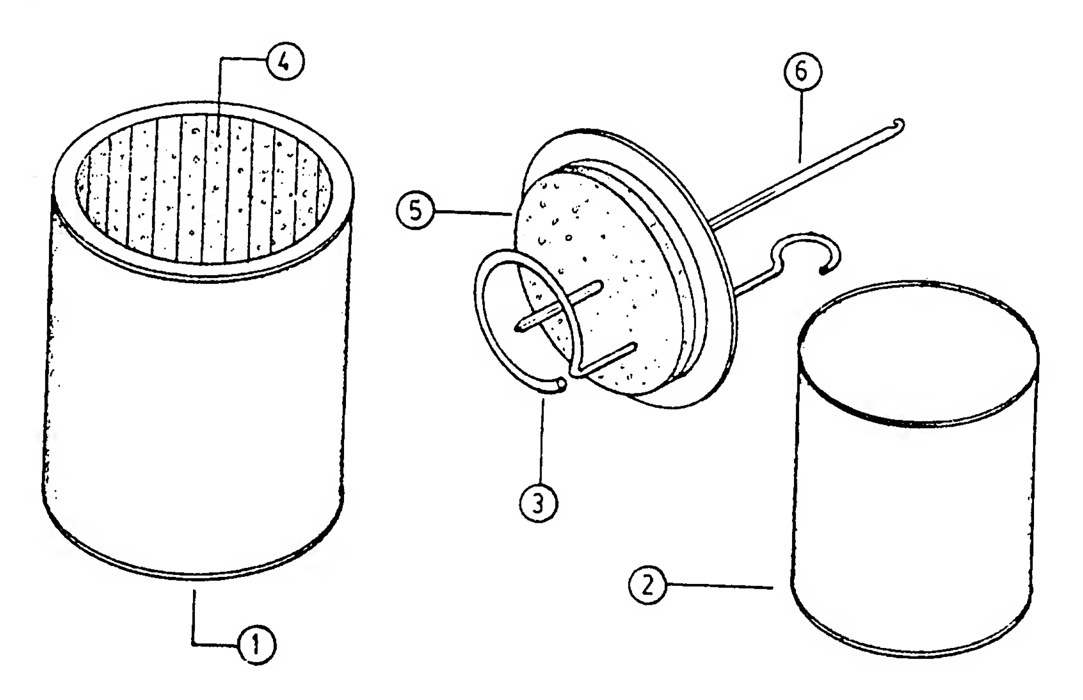


Fig. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Outer vessel.	1.	Tin can.	approx. 97mm dia. x 127mm.
2 - Inner vessel.	1.	Tin can.	approx. 76mm dia. x 100mm.
3 - Stirrer.	1.	Galvanised iron wire.	10 gauge x approx. 300mm.
4 - Outer vessel insulator.	8.	Styrofoam strips.	6mm thick x 114mm long.
Outer vessel bottom insulator.	1.	Styrofoam.	6mm thick x 92mm dia.
5 - Outer vessel cover.	1.	Tin sheet (lid of can).	approx. 97mm dia.
Cover insulator.	1.	Styrofoam.	76mm dia. x 6mm thick.
6 - Thermometer.	1.	Laboratory thermometer - 10°C to 110°C.	300mm long.
Thermometer holder.	1.	Rubber grommet.	Grommet with 6mm dia. hole.

6- CONSTRUCTION DETAILS

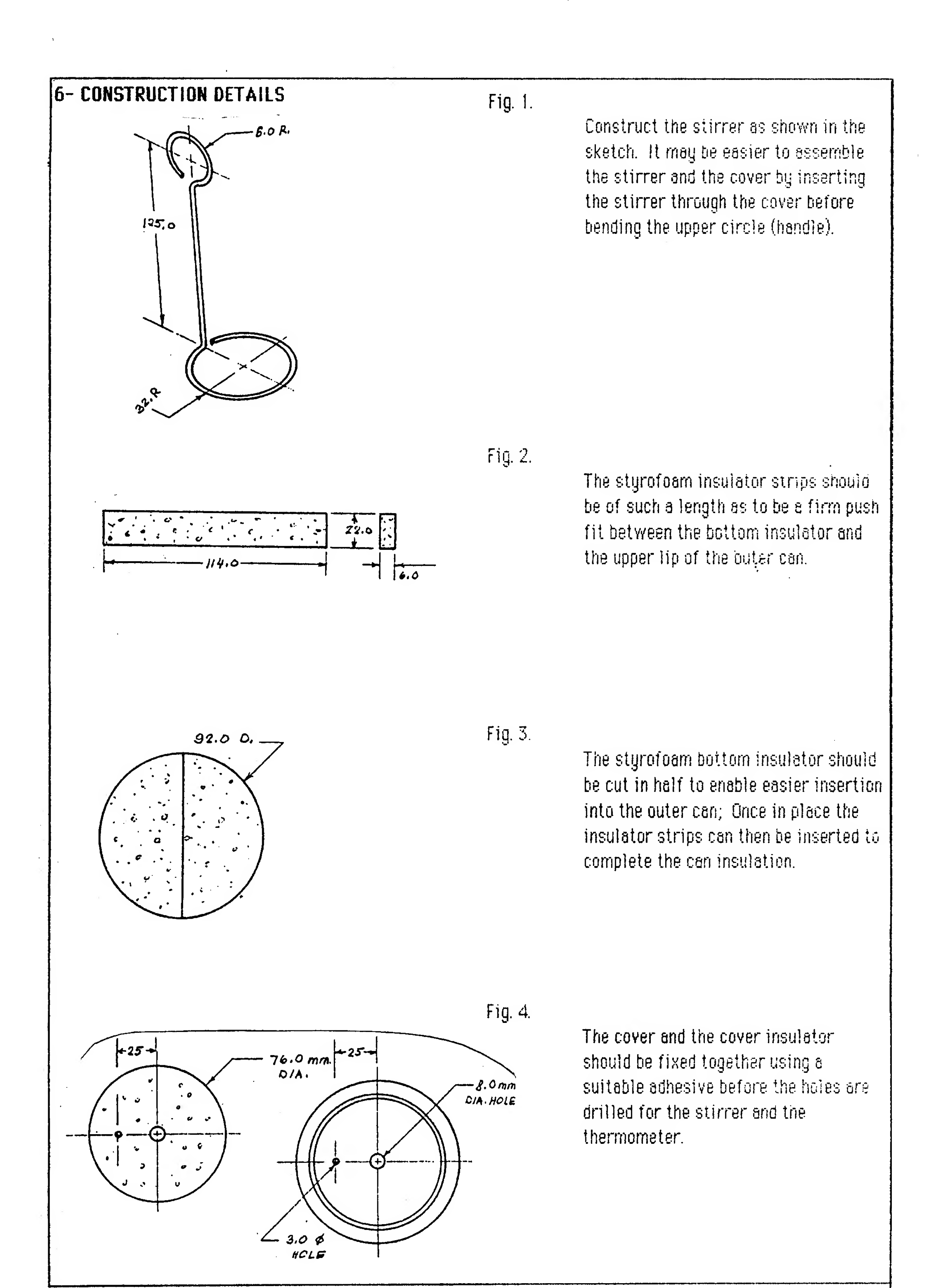


Fig. 1.

Construct the stirrer as shown in the sketch. It may be easier to assemble the stirrer and the cover by inserting the stirrer through the cover before bending the upper circle (handle).

Fig. 2.

The styrofoam insulator strips should be of such a length as to be a firm push fit between the bottom insulator and the upper lip of the outer can.

Fig. 3.

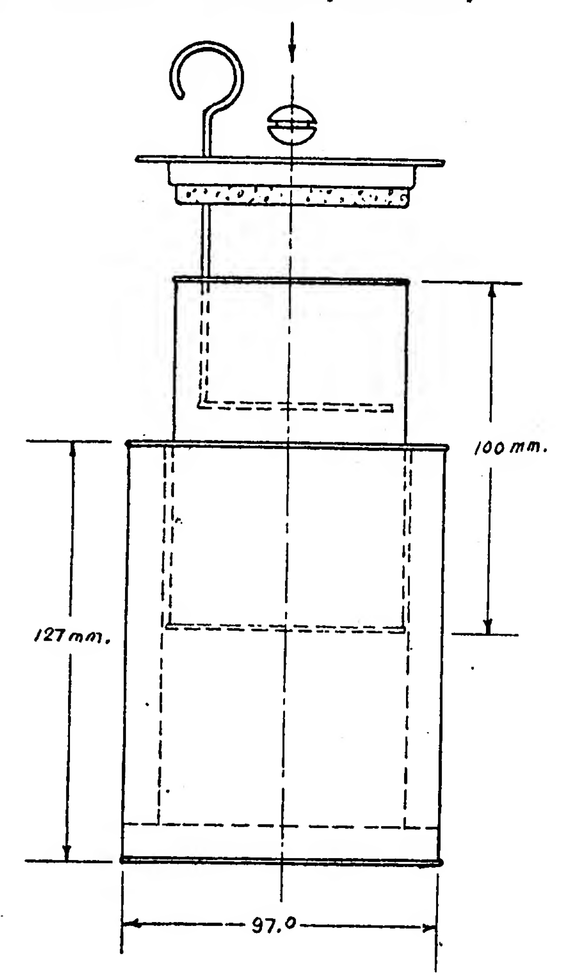
The styrofoam bottom insulator should be cut in half to enable easier insertion into the outer can; Once in place the insulator strips can then be inserted to complete the can insulation.

Fig. 4.

The cover and the cover insulator should be fixed together using a suitable adhesive before the holes are drilled for the stirrer and the thermometer.

6- CONSTRUCTION DETAILS (Continued)

Assembly diagram.



Note: The thermometer is pushed through the rubber grommet to the required depth such that the grommet just rests on the lid of the calorimeter.

7- APPROXIMATE COST OF ONE ITEM (in US $)

$1.50. not including the thermometer.

8- METHOD OF USE

As described in standard laboratory manuals.

9- COMMENTS

All dimensions can be modified to suit the dimensions of cans which may be available, and which are different from the cans indicated in the construction details.

1- ITEM

CALORIMETER

2- PURPOSE

To be used in experiments on heat of solutions, heat of reactions, or energy transfer, at the secondary level.

3- INFORMATION SUBMITTED BY

Institute for the Promotion of Teaching Science and Technology Bangkok, Thailand.

4- LINE DRAWING OF PROTOTYPE

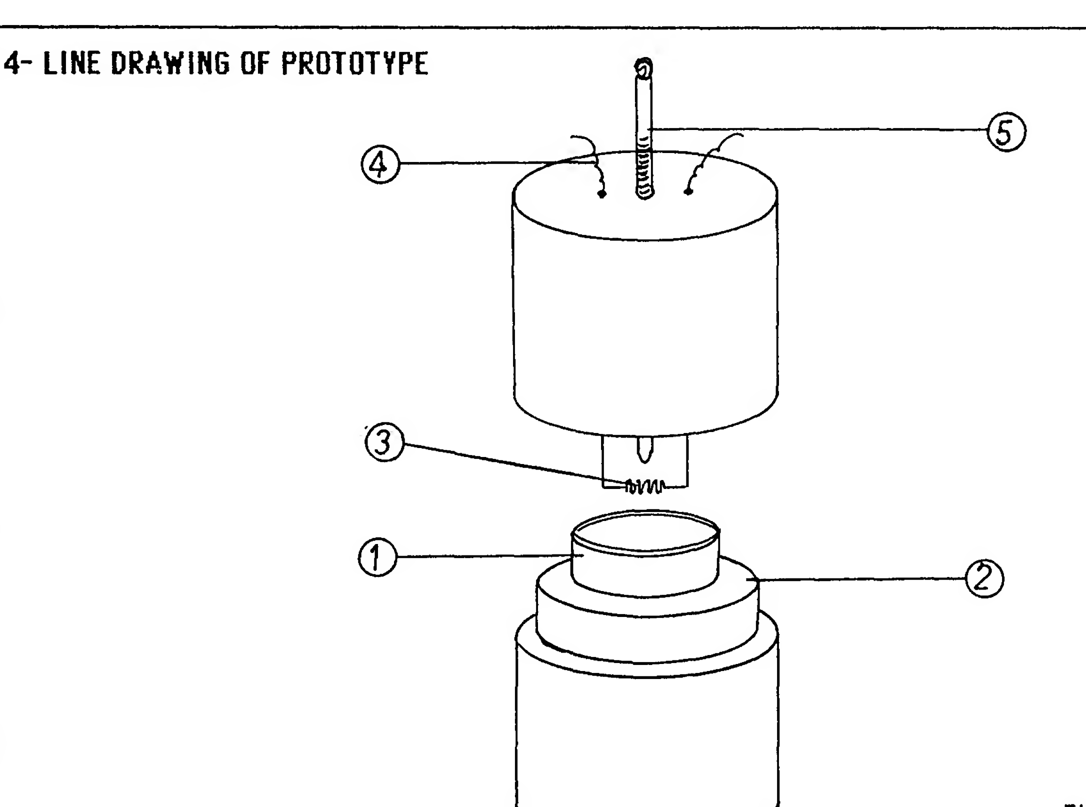


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1. Container.	1.	Metal can.	approx 50mm dia x 70mm long.
2. Container Insulation.	1.	Styrofoam	---
3. Heater.	1.	Wirewound Heater Coil 1 ohm, 2.5 watt.	---
4. Connecting leads.	2.	Insulated copper wire.	approx 15cm long.
5. Thermometer.	1.	Laboratory thermometer	approx 6mm dia.

6- CONSTRUCTION DETAILS

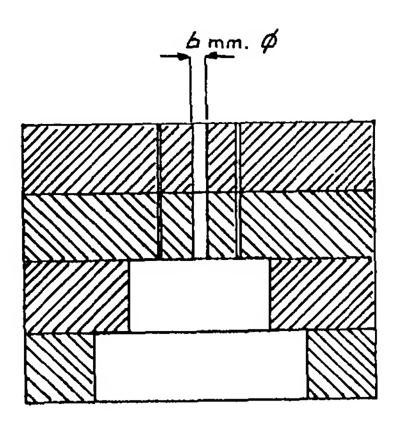
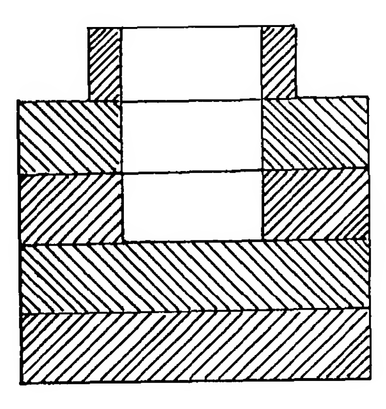


Fig.1. The sketch indicates how the styrofoam insulation for the container can be constructed from thin pieces of styrofoam. Mark out the required outside diameter (and inside diameter when applicable). Using a hot wire* cutter, or small sharp knife; cut each piece to the required shape. Using a suitable adhesive for styrofoam each piece can be glued to the next to build up the shape required. The holes for the wires and thermometer would be drilled after assembly.



Other than for the thermometer, dimensions have not been shown since they will depend upon the size of can available for use as the calorimeter. As a rough guide allow a 2cm thickness of insulation all around the calorimeter.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.5 not including the thermometer

8- METHOD OF USE

1 - The electric circuit would not be required if the heat of solution and heat of reaction activities are being undertaken.

2 - For the energy transfer activity a d.c. voltage supply of approx. 2.5. volt could be used with the heater indicated.

9- COMMENTS

*A hot wire cutter can be made from a suitable length of Nichrome wire and a low voltage (approx. 6 volt) d.c. supply. A variable resistor may also be required to control the current through the circuit (temperature of the wire).

1- ITEM

RESONANCE TUBE APPARATUS.

2- PURPOSE

For sound experiments.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

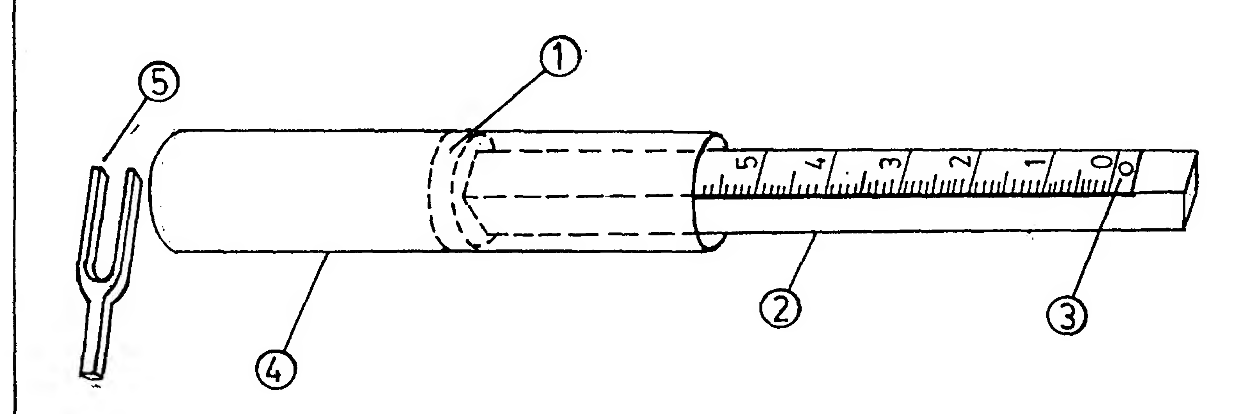


FIG . A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Washer.	1.	Solid rubber washer.	20mm dia. x 5mm thick.
2 - Plunger.	1.	Wood.	310mm x 12mm x 12mm.
3 - Scale.	1.	Metric plastic scale.	29.5cm long.
4 - Tube.	1.	PVC pipe.	20mm internal dia. x 300 mm long.
5 - Tuning fork.	1.	Tuning fork and pad.	

Tools: Hammer; woodsaw; hacksaw; nails.

6- CONSTRUCTION DETAILS

Fig. 1.

Using the hacksaw cut a length of 300mm off a 20mm internal diameter length of PVC pipe. Remove the rough edges to give a smooth finish at both ends.

Fig. 2.

Use the woodsaw to cut a square wooden plunger of size 310mm x 12mm x 12mm. Carefully cut a 30cm plastic rule at the 29.5cm mark and fix this scale to the plunger, using small nails, so that the 29.5 mark is at one end of the plunger as in the sketch.

Nail the rubber washer to the end of the plunger at the 29.5 cm mark.

Assemble the apparatus by inserting the plunger into the pipe and pushing it through until the end of the washer is flush with the end of the pipe.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.00.

8- METHOD OF USE

Take a tuning fork and strike it on the pad to produce a sound. Slowly withdraw the plunger down the tube at the same time bringing the tuning fork near to the open end, as shown in Fig. A. Note the reading on the scale where the tuning fork gives the maximum sound. This reading gives the 'node' and the end of the pipe i.e. the zero point, the 'antinode'. Similarly other nodes and antinodes can be found with this simple apparatus.

9- COMMENTS

1- ITEM

EXPLORATION OF SOUND APPARATUS.

2- PURPOSE

To show (1) Sound is produced by vibration of particles; (2) Tightness of the wire affects pitch of the sound; (3) Length of the wire and its material affects pitch of the sound.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

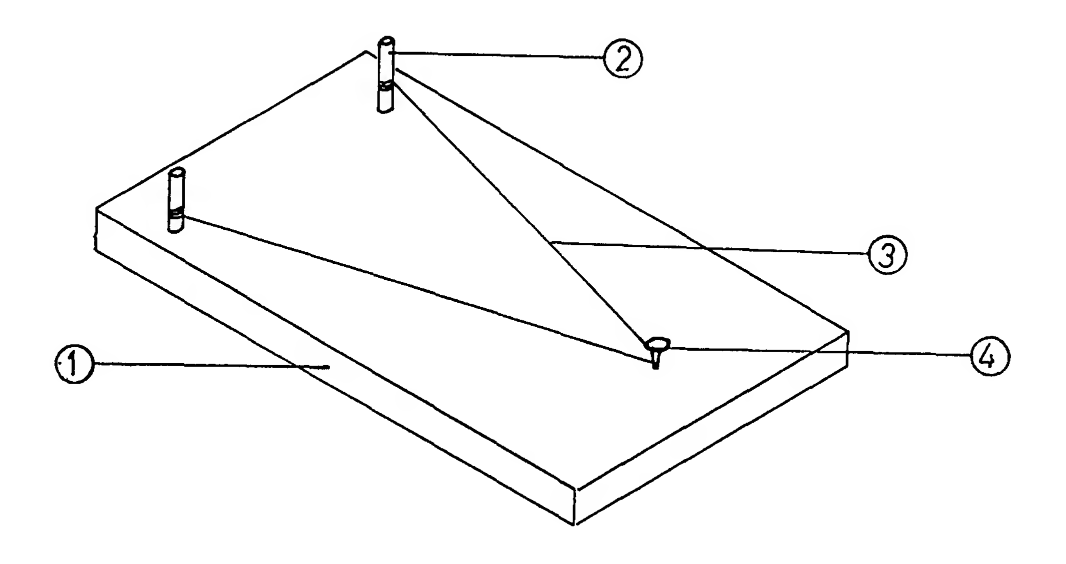


FIG. A.

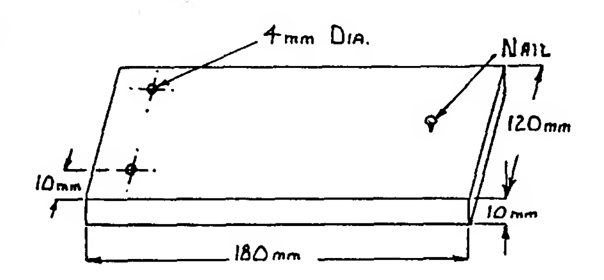
5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Baseboard.	1.	Wood.	180mm x 120mm x 10mm
2 - Pegs.	4.	Wooden dowel pins.	4mm dia. x 15mm long.
3 - Wire	1.	Thin steel wire.	1m.
4 - Spigot.	1.	Nail.	

Tools: Woodsaw; Chisels.

6- CONSTRUCTION DETAILS

Fig. 1.



Construct the wooden baseboard of size 180mm x 120mm using 10mm thick plywood. Drill two 4mm dia. holes to a depth of approx. 8mm at a suitable distance apart as indicated in the sketch. Smooth down all surfaces using sandpaper. Hammer in a nail such that it is firmly located and protruding approx. 10mm above the surface of the board.

Cut four dowel pins of 4mm dia. and 15mm long. These should be a tight push fit in the two holes in the baseboard. Fix a length of the wire between two of the dowel pins and fix a similar length of thread around the other two dowel pins (this could be done by drilling a small hole through the side of the dowel pins and passing the wire (thread) through the hole and wrapping it for two or three turns around the pin).

Take the dowel pins with the wire and insert them in the holes in the baseboard, taking the centre of the wire around the spigot, as indicated in Fig. A. Rotate one or both of the dowel pins so as to tension the wire.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50.

8- METHOD OF USE

Pluck the wire and sound will be heard due to the vibrations. Tighten the wire strongly and observe the effect on the pitch of the sound. Increase the length of the wire and observe the effect on the pitch of the sound. Repeat the activity using the thread. This indicates that sound can be produced by vibrations of different materials.

9- COMMENTS

1- ITEM

A SOUND KIT.

2- PURPOSE

To demonstrate that (i) sound is a type of energy.
(ii) sound is produced by vibrations.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

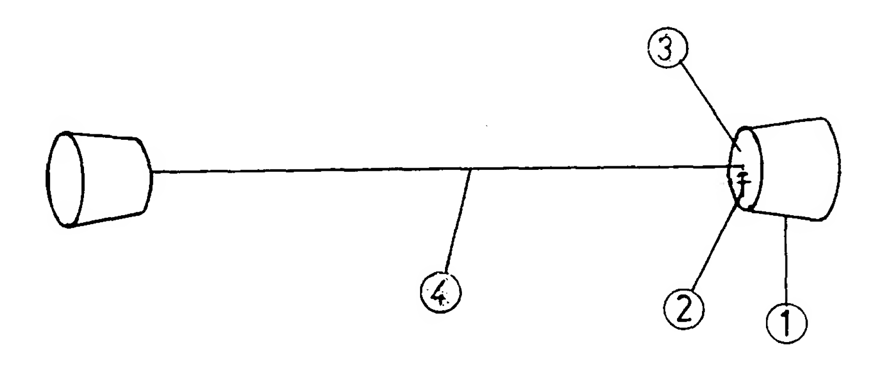


FIG . A.

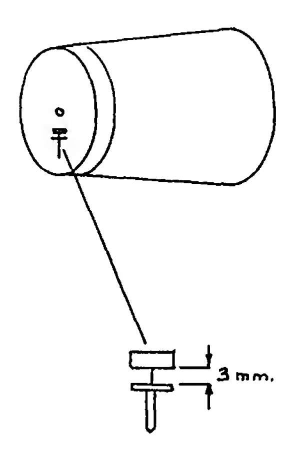
5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Cups.	2.	Plastic or paper cups.	as available.
2 - Nails.	1.	Small nail.	
3 - Diaphragm.	1.	White paper.	
4 - Thread.	1.	Thread.	Half metre.

Tools: scissors; gum; scotch tape; pin.

6- CONSTRUCTION DETAILS

Fig. 1.



Take two plastic or paper cups and, using the scissors, remove the bottoms. Using the gum or scotch tape fix a piece of white paper over the bottom of the cup stretching the paper as tight as possible. This forms the diaphragm. Make a small pin hole in the centre of the diaphragm and just below the hole, on one cup only, hang the small nail as indicated in the sketch, using the scotch tape.

To complete the apparatus feed the ends of the thread through the holes in the diaphragm and fix in place by tying a small knot.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.30.

8- METHOD OF USE

Let two pupils, each holding a cup, move apart until the thread is taught. If one pupil speaks into his cup he can be heard by the other pupil holding his cup to his ear. Observe the small nail which vibrates due to the vibration when the sound is produced and transmitted through the thread.

9- COMMENTS

1- ITEM

REFLECTION OF SOUND APPARATUS.

2- PURPOSE

To show that solid surfaces reflect sound waves and to determine the angle of the reflected sound wave.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

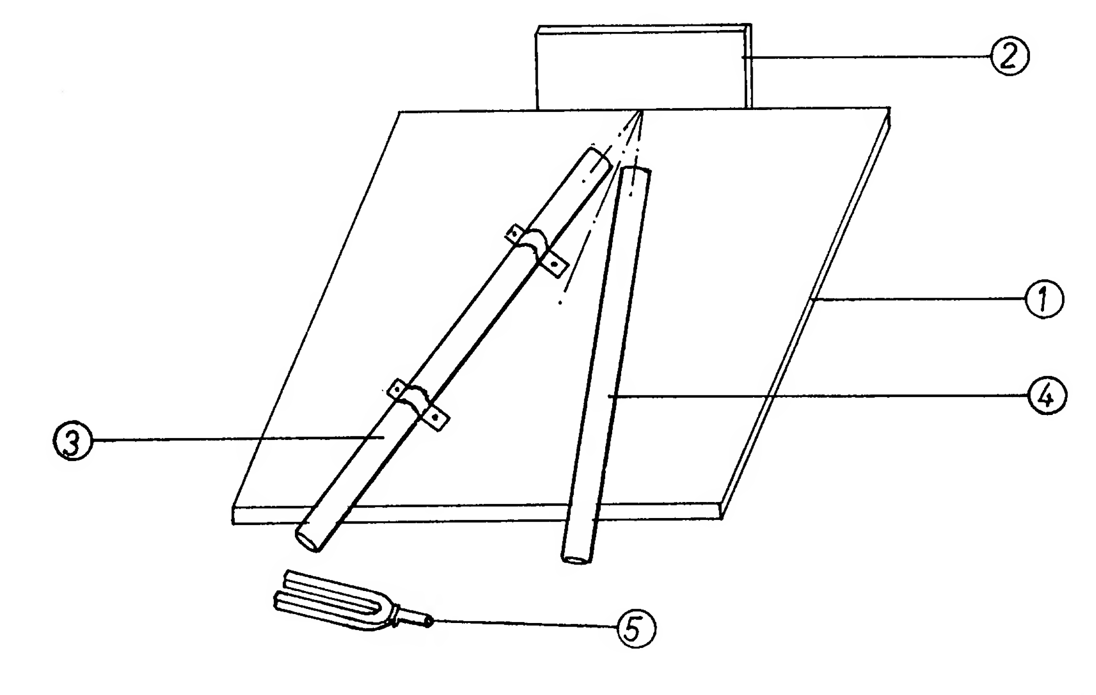


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Base,	1.	Wood.	400mm x 300mm x 5mm.
2 - Reflector.	1.	Cardboard.	80mm x 40mm.
3 - Fixed tube.	1.	PVC pipe.	12mm dia. x 450mm.
4 - Movable tube.	1.	PVC pipe.	12mm dia. x 450mm.
5 - Sound emitter.	1.	Tuning fork and pad.	
		Pipe clips.	
		Nails.	

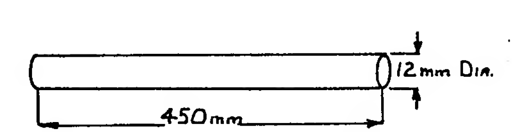
Tools: Woodsaw; hammer.

6- CONSTRUCTION DETAILS

Fig. 1.

Using the wood saw prepare a wooden base of 400mm x 300mm.

Fig. 2.



From a 12mm dia. length of PVC pipe cut two tubes of 450mm length.

Fig. 3.



Obtain two pipe clips or, alternatively, construct them from a piece of thin metal sheet as indicated in the sketch.

Cut a sheet of stiff cardboard to a size of 80mm x 40mm. Nail this piece of cardboard centrally along the 400mm edge of the baseboard with the 40mm side vertical.

Draw a line at right angles to the cardboard along the baseboard Using the pipe clips fix one of the tubes at 30° to the normal as shown in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.00.

8- METHOD OF USE

Take the tuning fork and strike it on the pad to produce a sound. Bring it near to the end of the fixed PVC pipe. Place the second PVC pipe on the baseboard and listen for the sound through this pipe. Adjust this pipe so that maximum sound can be heard through the pipe. It is observed that the angle made by this pipe is equal to the angle of the fixed pipe i.e. 30°, which indicates that the solid surface reflects the sound waves making an equal angle with the normal.

9- COMMENTS

1- ITEM

LIGHT SOURCE FOR OPTICS EXPERIMENTS.

2- PURPOSE

For confirming the elementary principles of geometric optics.

3- INFORMATION SUBMITTED BY

FUNBEC, Brazil.

4- LINE DRAWING OF PROTOTYPE

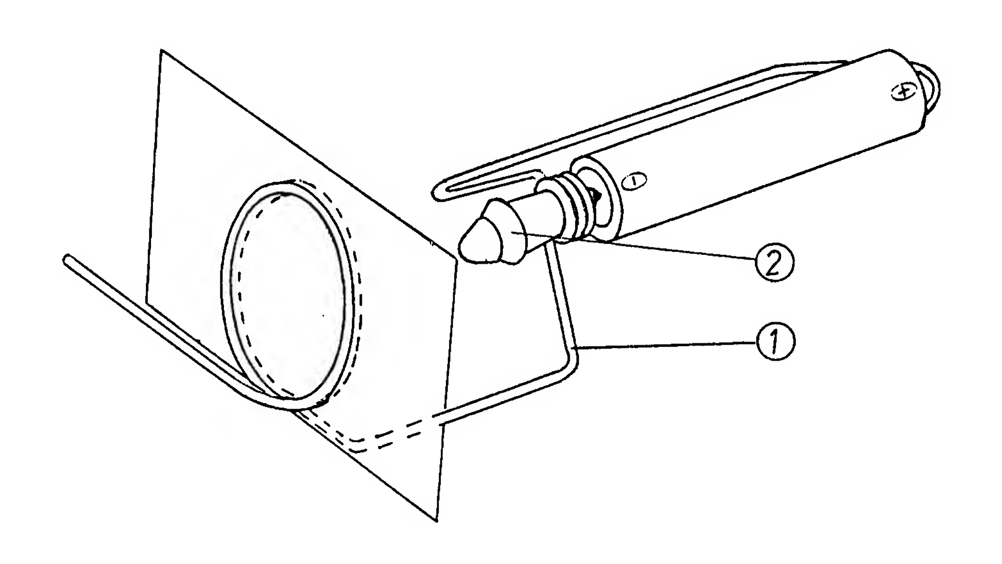


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Support.	1.	Copper wire.	2mm dia x 50cm long.
2- Light source.	1.	Bulb(1.5 volt).	
	1.	Battery type AA UM-3 (1.5v).	

6- CONSTRUCTION DETAILS

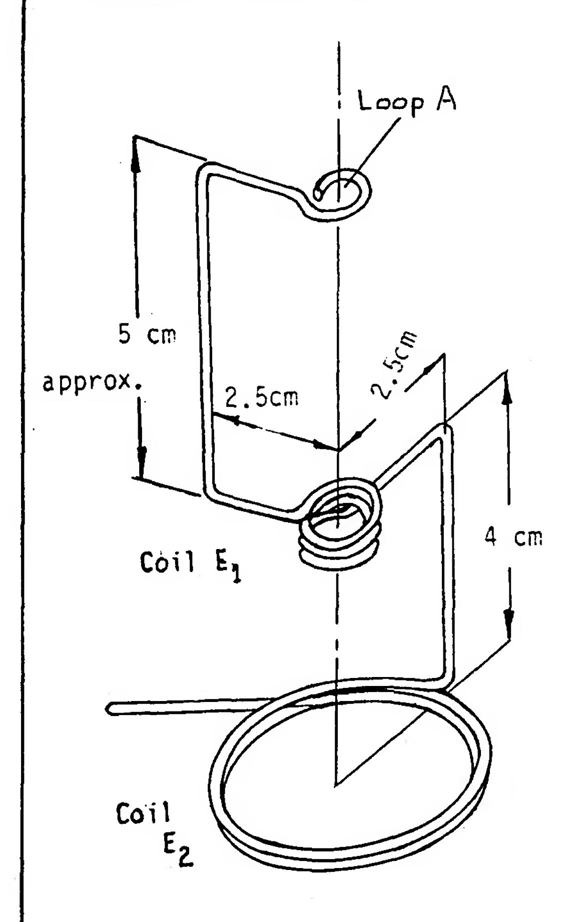


Fig.1.

By means of a pair of pliers shape the wire as shown in the sketch. To locate the bulb wind around the thread of the bulb in the direction of the thread.To locate the bulb with the battery a small indent into the negative pole of the battery may be necessary.

The diameter of the loop A. should be such that the positive pole of the battery just fits inside.

The diameter of the coil E2 should be from 2 to 5cm. The purpose of this coil is to hold filters or screens and at the same time provide stability for the apparatus. (See Fig.A.)

7- APPROXIMATE COST OF ONE ITEM (IN US$)

Less than $1.00.

8- METHOD OF USE

Screw the bulb into the coil E1. Place the battery with the negative pole towards the bulb. The positive pole should be held by the loop A, so that the battery is kept in constant pressure with the bulb. The metallic case of the battery should not be in contact with loop A.

9- COMMENTS

1- ITEM

PINHOLE CAMERA.

2- PURPOSE

To demonstrate image formation in a simple camera.

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project,
National Institute of Science and Technology, Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

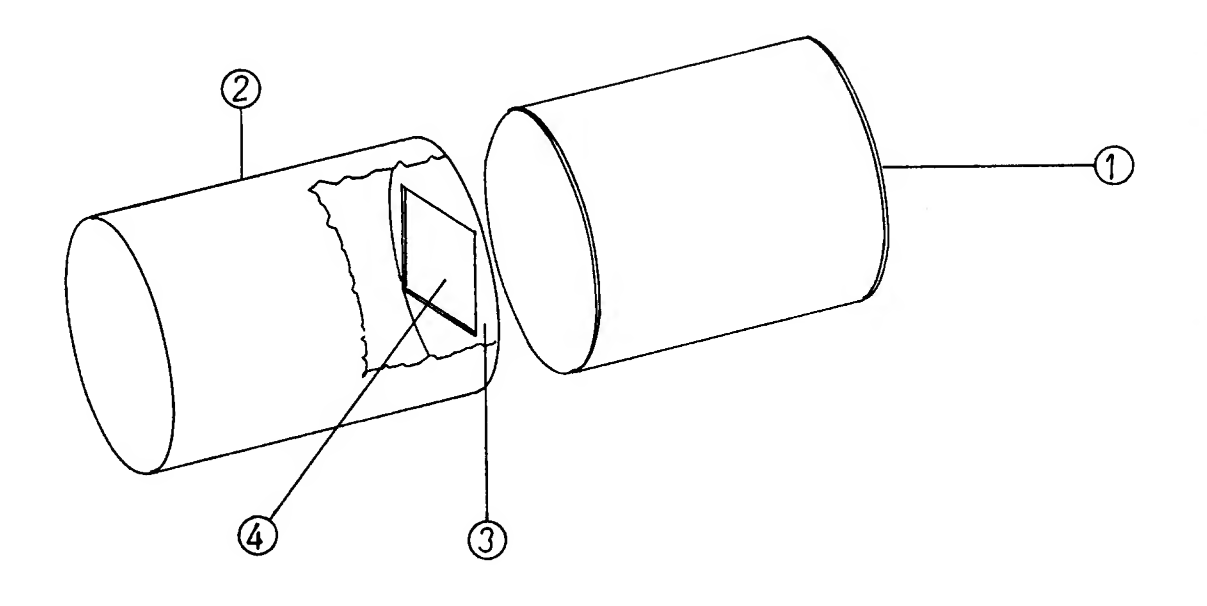


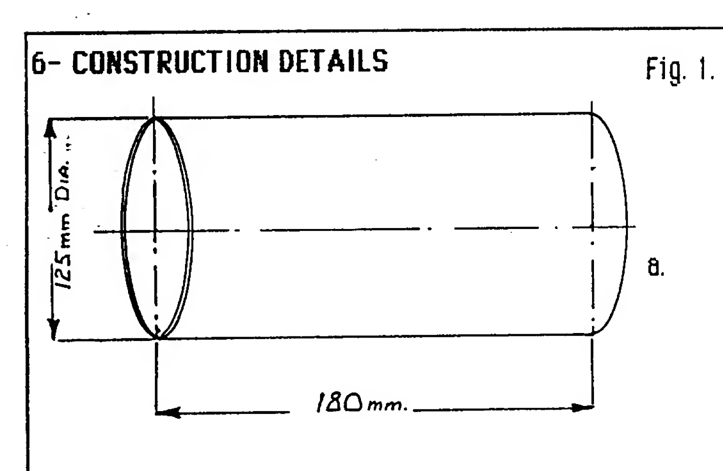
FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Camera body.	1.	Tin can.	approx. 130mm dia x 150mm.
2 - Draw tube.	1.	Stiff cardboard.	approx. 125mm dia x 180mm dia.
3 - Screen holder.	1.	Stiff cardboard.	123mm dia.
4 - Transluscent screen.	1.	Tracing paper.	80mm x 80mm.

6- CONSTRUCTION DETAILS

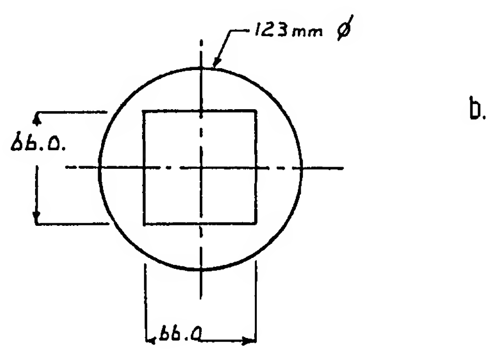
Fig. 1.



a.

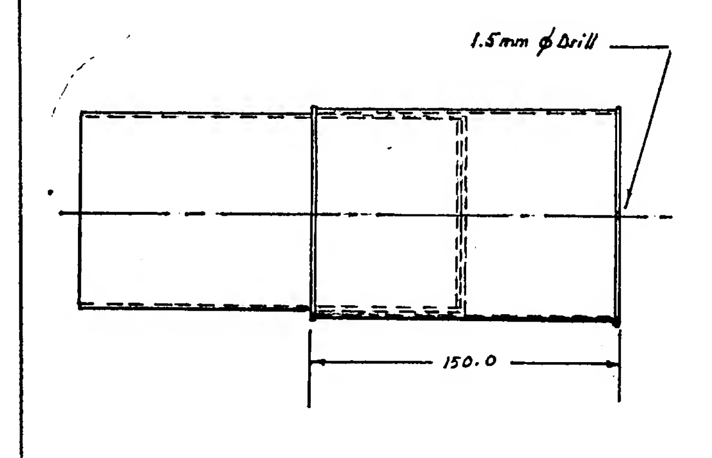
Construct a draw tube out of stiff cardboard to the size indicated in 1.a. The tube should just fit inside the tin can (camera body).

From a piece of stiff card cut out a circular disc to make the screen holder. The disc should just fit into the draw tube. Cut out a window in the holder as indicated in 1.b. From the piece of tracing paper cut out a square of 80mm x 80mm to form the screen. Using scotch tape fix this screen over the window in the screen holder.



b.

Insert the screen holder into one end of the draw tube and secure it in place using scotch tape. Ensure that the screen remains uncovered.



Drill a 1.5mm dia. hole in the centre of the can base. To complete the assembly insert the draw tube into the can with the window end inside the can as in Fig. A.

To minimise glare and produce and sharp image on the screen, the inside part of the camera body and draw tube should be painted black.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

Under $1.00.

8- METHOD OF USE

Aim the camera on a brightly lit object and adjust the draw tube until the sharp image is observed on the transluscent viewing screen..

9- COMMENTS

1- ITEM

MODEL OF A TELESCOPE.

2- PURPOSE

To construct and use a simple telescope, and demonstrate its principle.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids.
National Educational Equipment Centre. Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

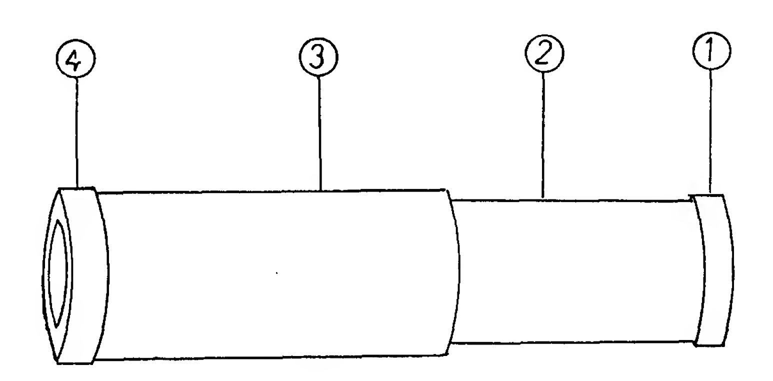


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Eye piece.	1.	Cardboard tube.	25mm I.D. x 15mm length
2- Eye piece tube.	1.	Cardboard tube.	25mm O.D x 100mm long
3- Objective tube.	1.	Cardboard tube.	28mm I.D. x 100mm long
4- Objective.	1.	Cardboard.	28mm O.D x 25mm length
Lens.	1.	Convex lens F.L. 35cm,dia. 28mm	
Lens.	1	Plano-concave lens, F.L. 2cm, dia. 25mm.	
		Scotch tape	

Tools: Scissors.

6- CONSTRUCTION DETAILS



Fig. 1.

Using the scissors and scotch tape construct a tube 15mm long and having an inside diameter of 25mm. Insert, and fix in place, a plano-concave lens of focal length 2cm and dia. 25mm. This will form the eye of the telescope.

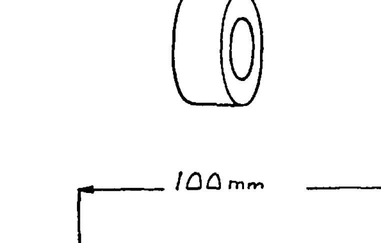


Fig.2.

Construct a tube from the cardboard of 100mm length and 25mm outside diameter. This tube should be a tight push fit into the eye lens tube.

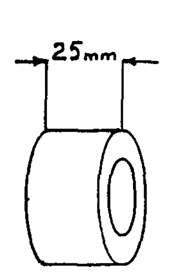


Fig.3.

For the objective lens construct a tube similar to the eye lens but with an inside diameter of 28mm. Insert, and fix in place, a convex lens of focal length 35cm and dia. 28mm.

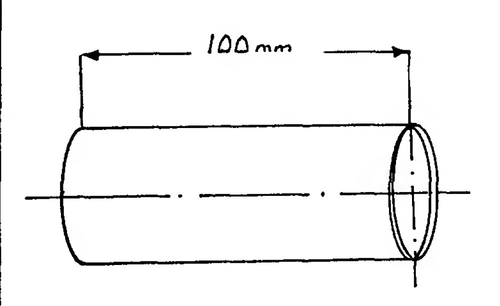


Fig.4.

Construct a tube similar to the tube to fit into the eye lens but having an internal diameter of 25mm. This tube should be a tight push fit into the objective lens tube. The 100mm long tube for the eye lens should be a sliding fit into this objective lens tube.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$2.00

8- METHOD OF USE

Complete the assembly as shown in Fig.A. Observe a distant object through the eye lens and bring it into focus by sliding the inner tube in or out whilst holding the outer tube.

9- COMMENTS

The dimensions of the tubes may need to be altered depending upon the diameters of the lenses available.

1- ITEM

PERSISCOPE.

2- PURPOSE

To see over the top of an obstacle - a practical application of angles of incidence and reflection with regard to mirrors.

3- INFORMATION SUBMITTED BY

Science Equipment Centre, Lagos, Nigeria.

4- LINE DRAWING OF PROTOTYPE

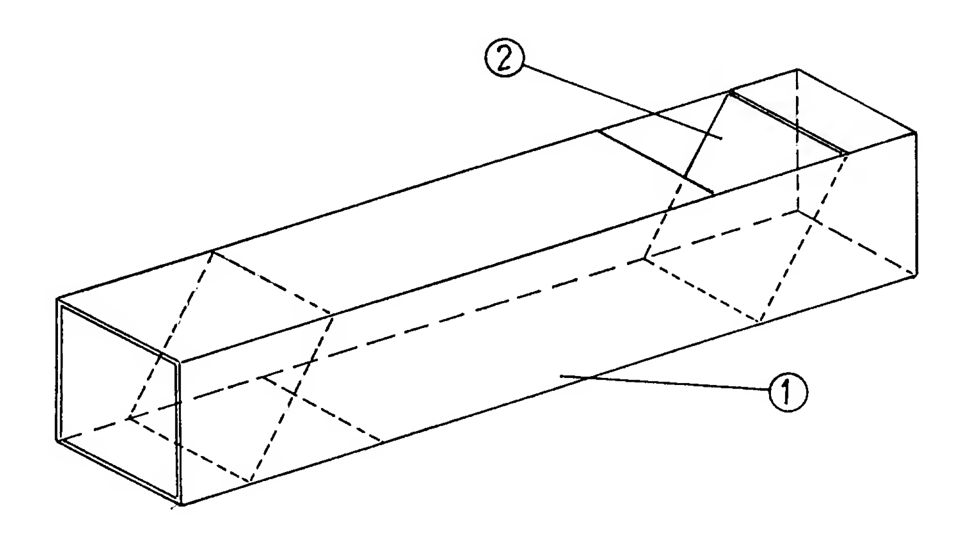


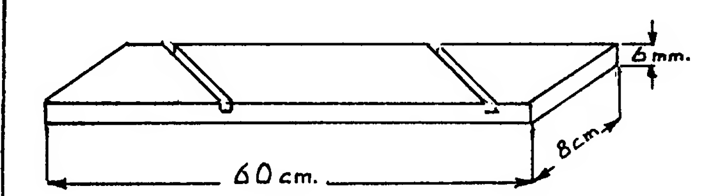
FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Case.	1.	Plywood.	2 pieces - 60cm x 8cm x 6mm. 2 pieces - 52.5cm x 8cm x 6mm.
2 - Mirrors.	2.	Glass mirror.	approx. 10cm x 7.2cm x 5mm.
		Nails.	
		Glue.	

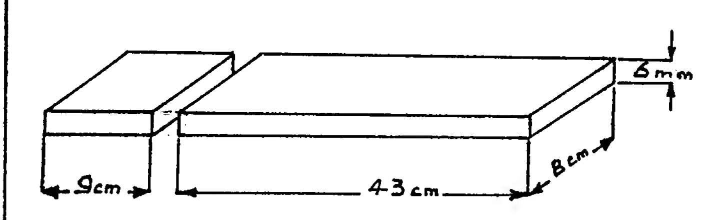
6- CONSTRUCTION DETAILS

Fig. 1.



Cut two pieces of 6mm plywood to a size of 60cm x 8cm. Cut two 5mm wide grooves at an angle of 45° as indicated in the sketch. These are to locate the mirrors.

Fig. 2.



Cut two pieces of 6mm plywood to a size of 52.5cm x 8cm. Then cut these pieces into two parts of length 9cm and 43cm, as indicated in the sketch.

Smooth down all surfaces with sandpaper.

To assemble, nail and glue one of the 43cm lengths to the two side pieces with their grooves facing inside. Then nail and glue the 9cm length from the other end so as to leave a window for looking into the mirror.

Turn the assembly over and slide in the mirrors. Nail and glue the remaining two pieces in place, so as to provide the periscope as shown in Fig.A.

7- APPROXIMATE COST OF ONE ITEM (IN US$) -----

8- METHOD OF USE

As for other types of periscopes.

9- COMMENTS

The periscope could be varnished but avoid splashing varnish on the mirrors.

1- ITEM

LIGHT REFLECTION BOX.

2- PURPOSE

To demonstrate that (i) Light travels in straight lines.
(ii) Light reflects in a straight line when it falls on a mirror.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.1

4- LINE DRAWING OF PROTOTYPE

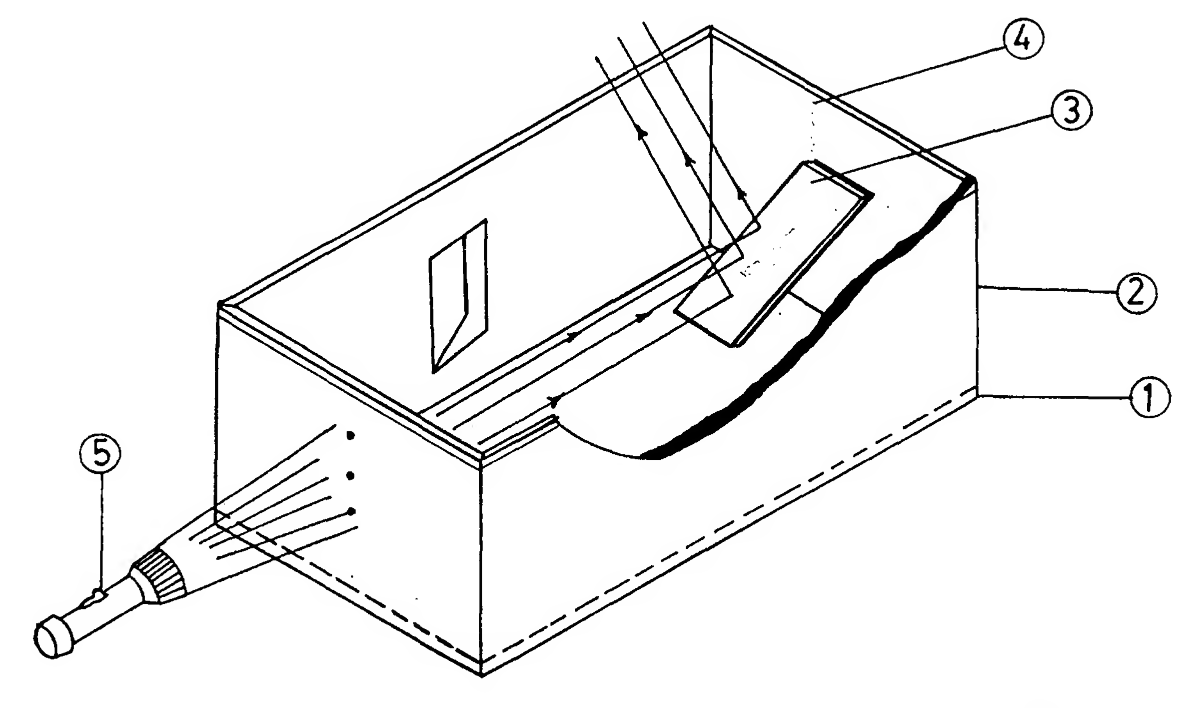


FIG. A.

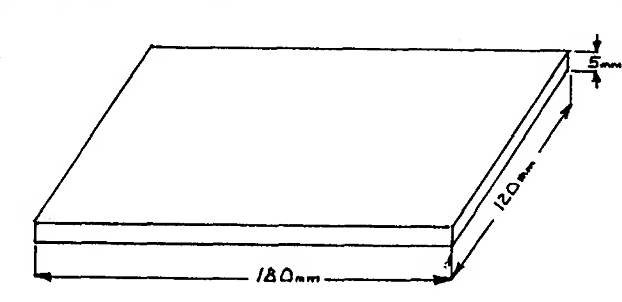
5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Base.	1.	Wood.	180mm x 120mm x 5mm
2 - Sides.	1.	Cardboard.	612mm x 100mm.
3 - Mirror.	1.	Mirror.	100mm x 15mm.
4 - Transparent cover.	1.	Transparent plastic sheet.	190mm x 130mm
5 - Light source.	1.	Hand torch.	

Tools: Woodsaw; scissors; scotchtape; drawing pins; needle; Plasticine; candle.

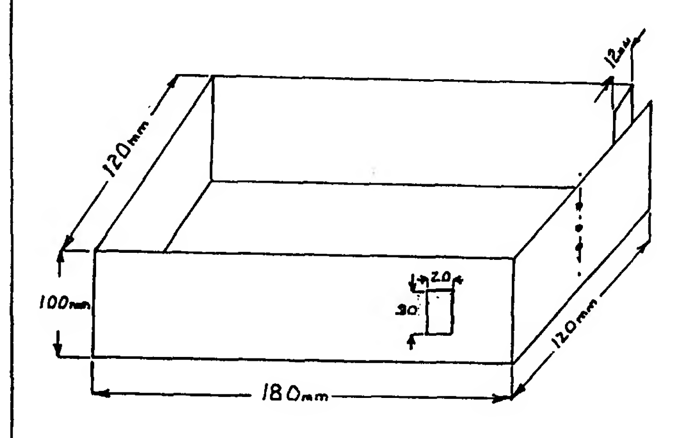
6- CONSTRUCTION DETAILS

Fig. 1.



From a 5mm thick piece of wood cut a base of size 180mm x 120mm.

Fig. 2.



From a sheet of stiff cardboard cut a strip of 100 wide and 612mm long. Mark out the strip as indicated in the sketch and cut out the window. Using a needle, pierce three holes, as shown, at one end. Bend to the shape of the base.

Using drawing pins, fit the sides around the base and pin in place.

Using plasticine locate the mirror in the box at approx. 45°, as shown in Fig. A. Cover the box with the transparent plastic sheet, holding it in place with the scotch tape.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.50

8- METHOD OF USE

Using a candle, fill the box with smoke via the window. Direct light from the torch through the pin holes onto the mirrow. Observe the straight lines of light falling on the mirror and being reflected from the mirror.

9- COMMENTS

An alternative design is to pierce holes in a horizontal direction and angle the mirror at approx 45° to end and one side. Reflected rays will be seen within the box possibly more clearly than the design described.

1- ITEM

REFRACTION AND REFLECTION OF LIGHT APPARATUS.

2- PURPOSE

To demonstrate the principle of refraction and reflection of light.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

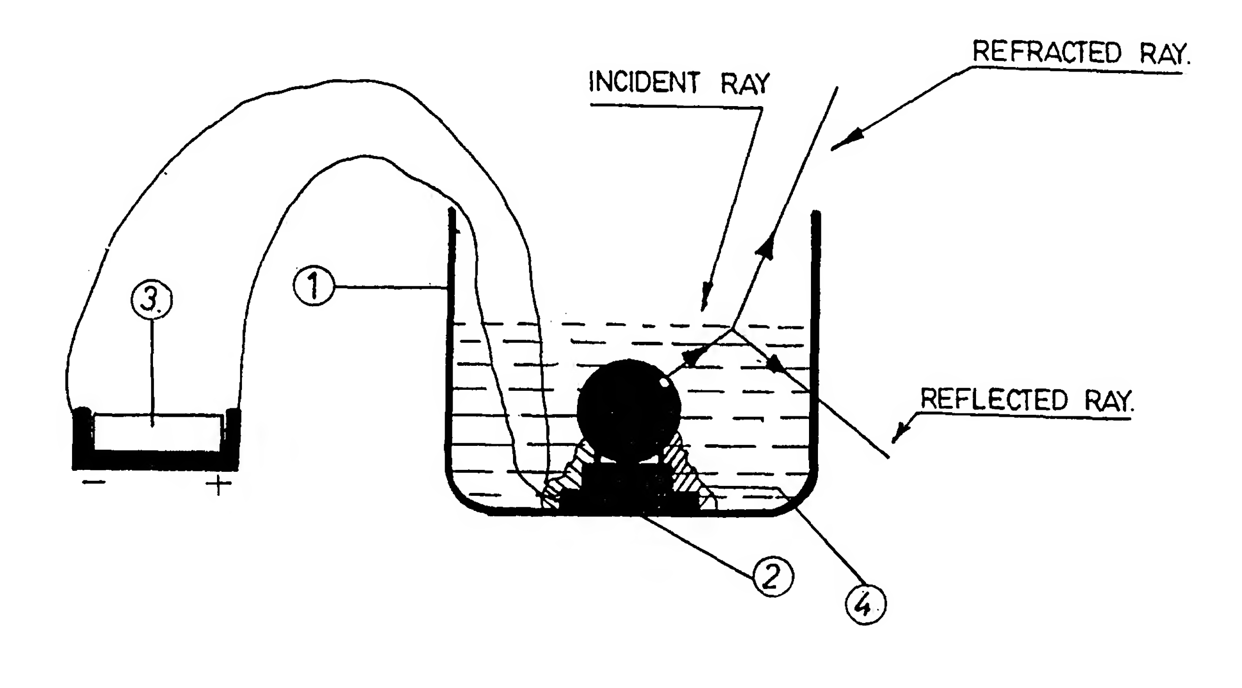


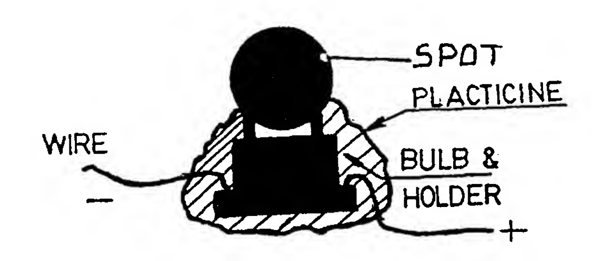
FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Container.	1.	Glass trough.	
2 - Light source.	1.	Bulb holder with bulb (Torch bulb, 1.5 volt)	
3 - Battery.	1.	1.5 volt dry cell, and holder.	
4 - Sealing compound.	1.	Plasticine.	
		Connecting leads.	

6- CONSTRUCTION DETAILS

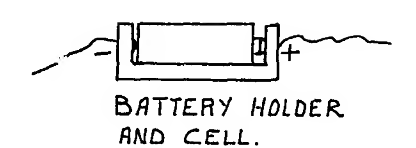
Fig. 1.



Connect the leads to the bulb holder and screw the bulb into the holder. Using a black marker pen (or black paint) paint the bulb black leaving a small clear spot towards the top of the bulb as indicated in the sketch.

Place the bulb holder and bulb in the bottom of the glass trough and fix in place using the plasticine. The plasticine should completely cover the wire connection, the bulb holder, and the bottom part of the bulb, so as to make a water tight seal and insulate the arrangement to prevent any short circuit occuring.

Fig. 2.



Connect the battery holder to the two leads from the bulb holder and check that the bulb lights.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$2.00.

8- METHOD OF USE

Pour water into the glass trough until the bulb is completely under water. Insert the battery into the battery holder. In a darkened room observe the path of light from the small hole. The light will be refracted while passing through the water into the air and, since the water surface will be seen to be shining, some part of the light will be reflected at the water surface. The path or rays of light are indicated as incident ray, reflected ray and refracted ray in Fig. A.

9- COMMENTS

Under no circumstances should this apparatus be connected to any source of electrical supply other than a 1.5 volt dry battery.

1- ITEM

MODEL OF THE SOLAR SYSTEM.

2- PURPOSE

To demonstrate planets revolving around the sun.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids.
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

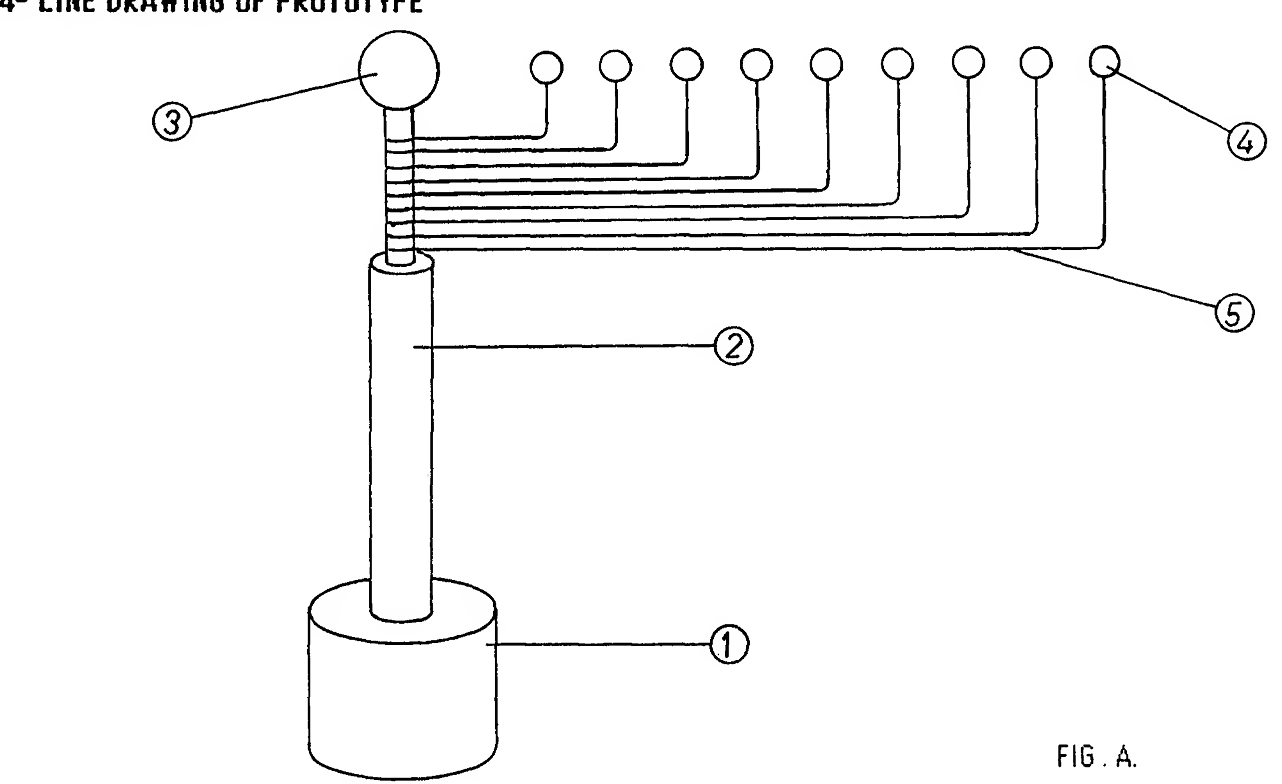


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Base.	1.	Large metal can filled with clay.	as available.
2 - Support rod.	1.	Wood (or used bicycle axle).	12mm dia. x 150mm.
3 - The Sun.	1.	Styrofoam sphere.	5cm dia.
4 - The Planets.	9.	Styrofoam spheres.	2cm dia.
5 - Support wires.	9.	Steel wire.	approx. 2m x 18 gauge.

Tools: Pliers; hammer; knife; file.

6- CONSTRUCTION DETAILS

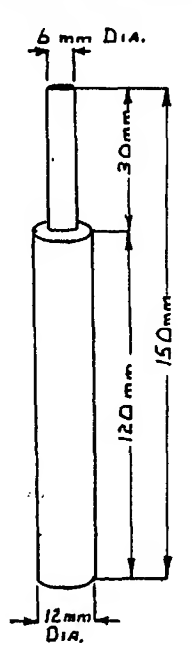


Fig. 1.

Using a piece of 12mm dia. wooden dowelling construct the support rod as indicated in the sketch. (Alternatively the axle from a bicycle may be suitable).
Insert the support rod into the can filled with clay, and allow to set.

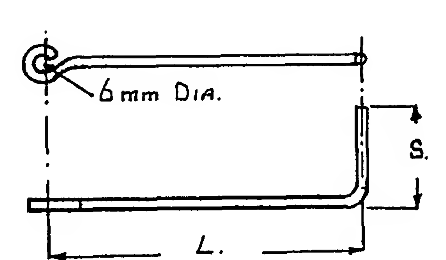


Fig. 2.

Construct nine support wires as indicated in Fig. 2. The lengths 'L' could be 27cm, 24cm, 21cm, 18cm, 15cm, 12cm, 9cm, 6cm and 4cm. The lengths 'S' will vary according to the vertical distance of the wire below the sun e.g. for the planet at 27cm distance away the distance 'S' may be 55mm, for the one at 4cm away the distance 'S' may be 25mm. All planets should lie on the same axis as the sun.
Construct the 2cm dia styrofoam spheres and the 5cm sphere. Fix this latter sphere (the Sun) onto the support rod.
Commencing with the longest support wire fix a 2cm sphere onto the end and locate the wire over the support rod as shown in Fig. A.
Repeat this for the other wires, ensuring that each one is firmly located on the support rod but free enough to be rotated around the rod.

The planets, working outwards from the sun are: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.00.

8- METHOD OF USE

Movement of the planets around the sun can be discussed with the help of this model.

9- COMMENTS

Discussion regarding the movement of planets is likely to involve such matters as elliptical orbits and the different sizes (diameters) of the planets.

1- ITEM

MODEL TO DEMONSTRATE ECLIPSES.

2- PURPOSE

To demonstrate the solar and lunar eclipses.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre. Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

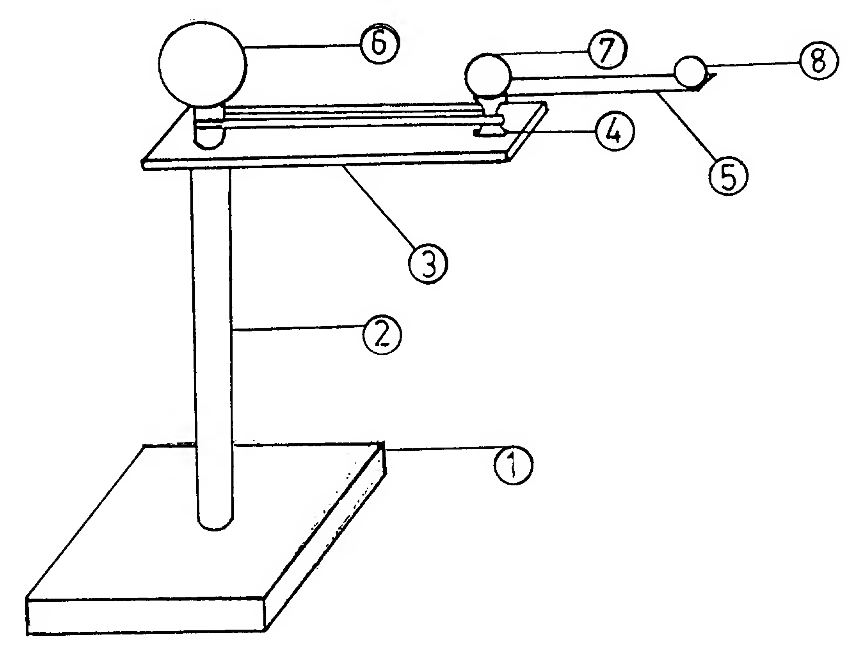


FIG . A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Base.	1.	Wood.	100mm x 100mm x 100mm.
			10mm dia. x 150mm.
2 - Support rod.	1.	Wood.	80mm x 20mm x 5mm.
3 - Support platform.	1.	Wood.	----
4 - Pivot.	1.	Wood or plastic cotton reel.	50mm x 10mm.
5 - Mount.	1.	Metal strip.	25mm dia.
6 - Sphere 'a'	1.	Styrofoam.	15mm dia.
7 - Sphere 'b'	1.	Styrofoam.	10mm dia.
8 - Sphere 'c'	1.	Styrofoam.	
		Nails.	
		Glue.	
		Rubber band.	
		Tools: Woodsaw; hammer;	
		tin snips; file; knife;	

6- CONSTRUCTION DETAILS

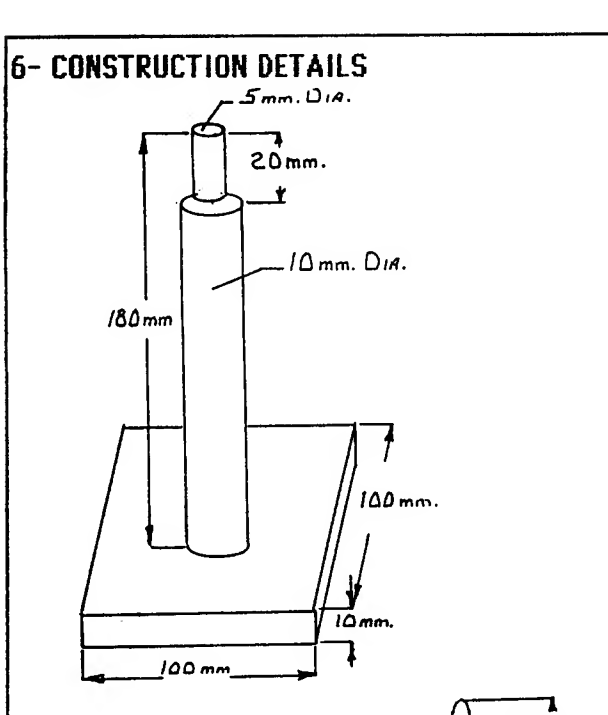


Fig. 1. Using the wood saw cut the wooden base to the size required. Take a wooden rod of 10mm dia x 180mm long and reduce the dia. at one end to 5mm, for a length of 20mm. With the aid of the hammer and nails fix the support to the centre of the base, as indicated in the sketch.

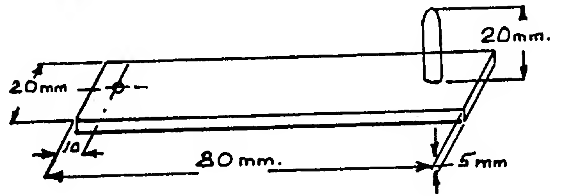


Fig. 2. Cut the support platform to size. Drill a 5mm dia. hole at one end and insert a nail at the other end as indicated in the sketch. The 5mm hole should just fit over the support rod.

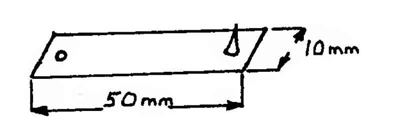


Fig. 3. Using the tin snips cut a tin strip of size 50mm x 10mm. Make a small hole at one end and insert a small nail at the other as indicated in the sketch.



Fig. 4. Nail the tin strip onto the cotton reel and fix the 10mm dia. styrofoam sphere onto the nail. Glue the 15mm dia. sphere to the strip above the centre of the cotton reel. The hole in the cotton reel should just fit freely over the nail in the support platform. Complete the assembly as shown in Fig. A. by fitting the support platform onto the rod and then fitting the 25mm dia sphere at the top of the rod. Stretch a rubber band over the rod and pivot and fit the pivot and mount on to the nail on the platform.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$2.00.

8- METHOD OF USE

Rotate the wooden support platform around the ball 'a' representing the sun. The small ball 'c', representing the moon will rotate around the ball 'b', representing the earth. Solar and lunar eclipses can thus be explained.

9- COMMENTS

1- ITEM

ASTRONOMY MODEL - GREAT BEAR, LITTLE BEAR, CASSEOPEIA, POLE STAR.

2- PURPOSE

To show the position of the great bear with respect to the pole star, and movement of the pole star, great bear, little bear and Casseopeia

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

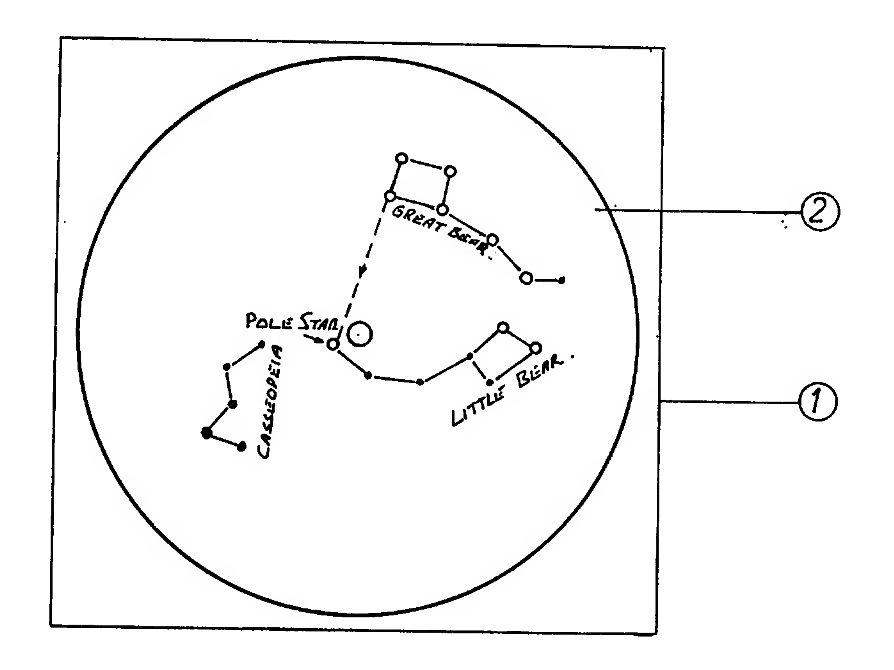


Fig. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Base.	1.	Cardboard.	320mm x 320mm
2 - Disc.	1.	Cardboard.	280mm dia.
	1.	Spring press stud.	
	1.	Sheet of dark blue paper.	

Tools: Scissors; compass; metric rule; bradawl; gum; white paint; brush.

6- CONSTRUCTION DETAILS

Fig. 1.

From a piece of stiff cardboard cut the base for the model to a size of 320mm x 320mm. On a separate piece of cardboard paste a sheet of blue paper and then cut out a disc of 280mm diameter.

6- CONSTRUCTION DETAILS (Continued)

Commence to mark out the star pattern by first marking in the position of the pole star. Using the dimensions given in Fig. 1. locate the positions of the great bear and Casseopeia on the horizontal line shown. Complete the constructions of the great bear, Casseopeia, and the little bear. Erase all construction lines (those shown as broken lines in Fig. 1) and paint the stars with white paint. Having completed the star chart make a small hole in the centre of the disc and the base. Using a small press stud (or similar fastener) fix the disc to the base in such a manner that the disc will rotate as shown in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (in US $)

$0.50.

8- METHOD OF USE

Rotate the disc and observe the rotation of Great Bear, Little Bear, and Casseopeia with respect to the Pole Star.

9- COMMENTS

1- ITEM

MOVING PICTURE DISC.

2- PURPOSE

To demonstrate how single pictures appear as a continuous movement, as on the cinema screen. (Persistence of Vision).

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

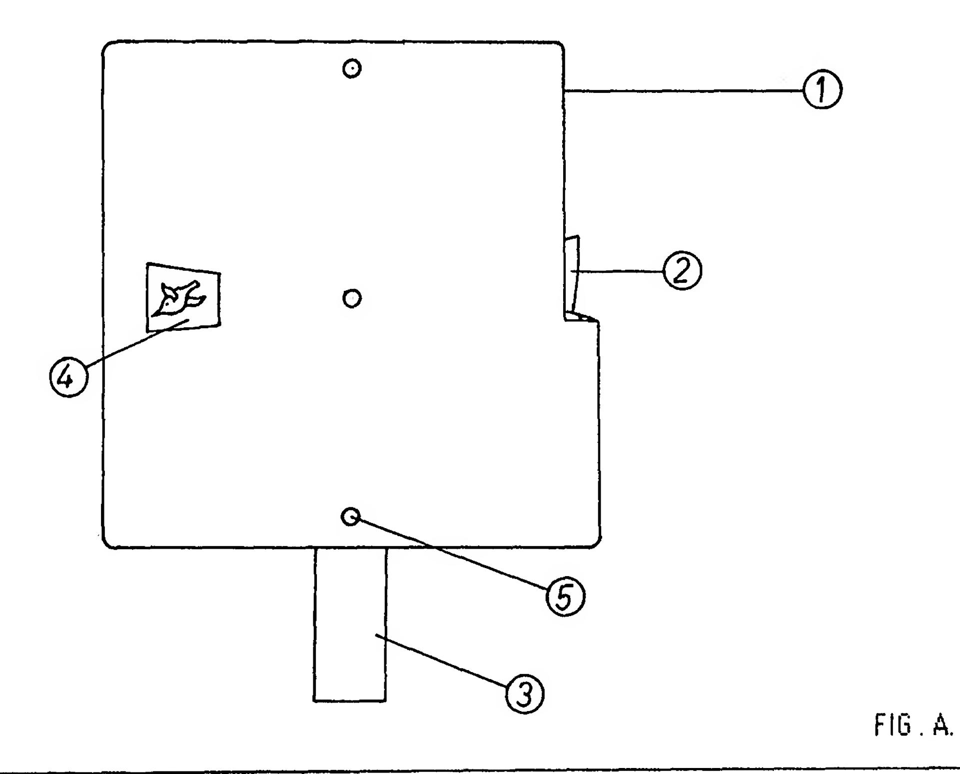


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Front and rear screens.	2.	Cardboard (or hardboard).	160mm x 160mm
2 - Picture wheel.	1.	Cardboard.	150mm dia.
3 - Handle.	1.	Wood.	240mm x 20mm x 10mm.
4 - Picture.	12.	Cardboard.	----
5 - Paper fasteners.	3.	Split pin type paper fasteners.	

Tools: Scissors; woodsaw; marker; rule.

6- CONSTRUCTION DETAILS

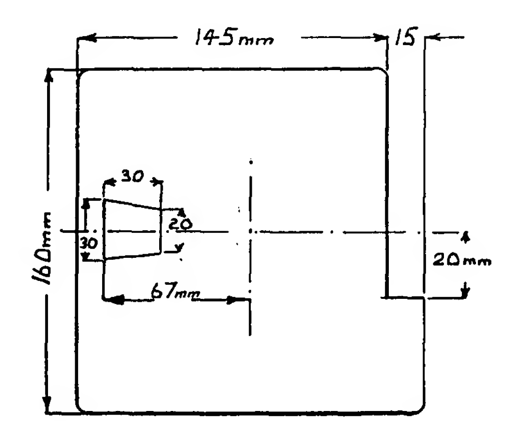


Fig. 1. From the cardboard (or hardboard), cut out a front and rear screen as indicated in the sketch. In the front screen cut out a window according to the sizes indicated.
From a piece of 10mm thick wood cut a handle of 240mm x 20mm.

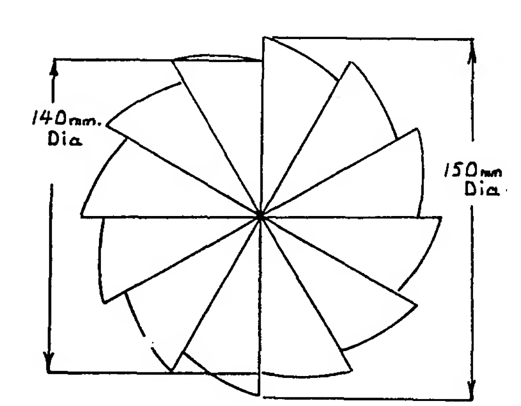


Fig. 2. From a piece of cardboard mark out and cut the picture wheel as shown in the sketch. Insert the wheel between the two screens and pivot at the centre using the split type paper fastener. Fix the assembly to the handle by using two more fasteners (a 'washer', slightly thicker than the cardboard, inserted between the screens at each of the two fasteners will ensure the wheel rotates freely).

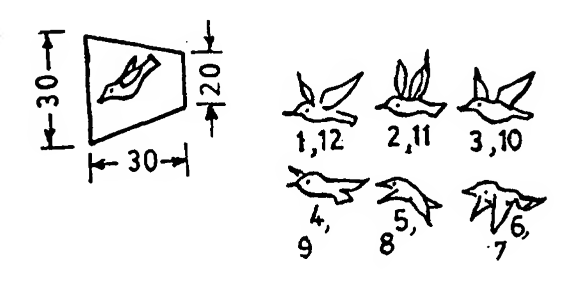


Fig. 3. Cut from cardboard twelve stencils, the size of the window in the front screen. On each stencil cut out the shape of a bird with the wings of each in a slightly different position (six stencils could be used with their picture repeated twice as indicated in the sketch). Rotate the wheel until the protruding flat edge is at the bottom of the finger stop. Place stencil one in the window and draw the shape of the bird. Remove the stencil, rotate the wheel to the next position and, using the second stencil, draw the bird. Repeat the process until each segment of the wheel has a drawing of a bird.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50.

8- METHOD OF USE

Slowly rotate the wheel with a finger and observe each picture. Gradually increase the speed of rotation until the picture of the bird will be observed as flying.

9- COMMENTS

1- ITEM

BATTERY HOLDER

2- PURPOSE

General use in simple electrical circuits.

3- INFORMATION SUBMITTED BY

FUNBEC, Brazil.

4- LINE DRAWING OF PROTOTYPE

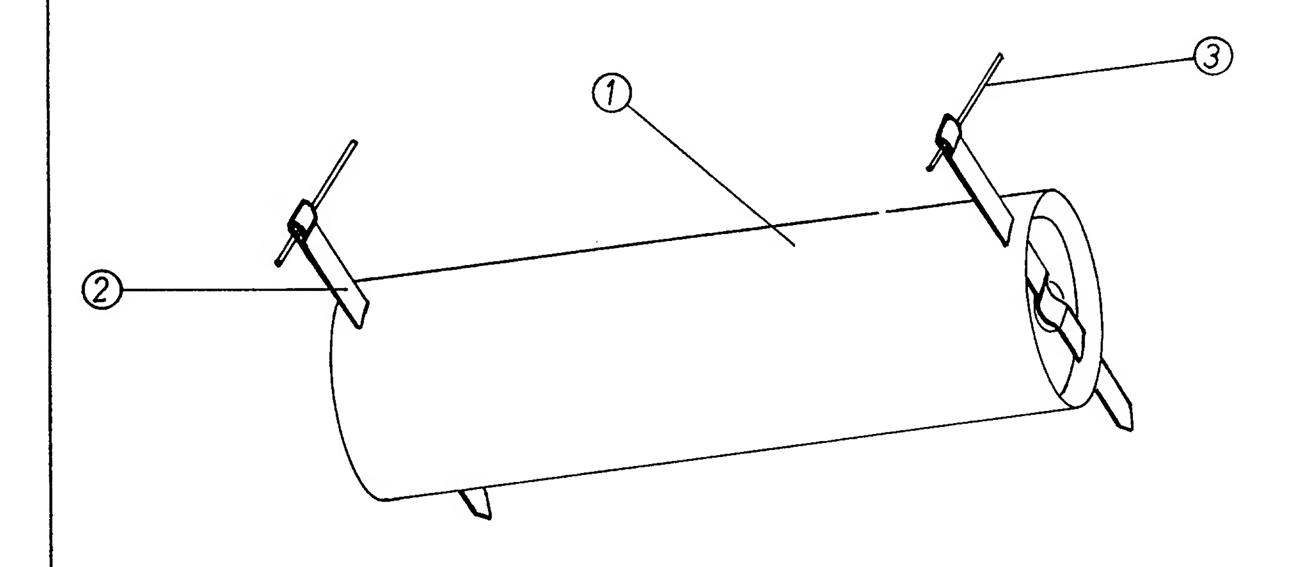
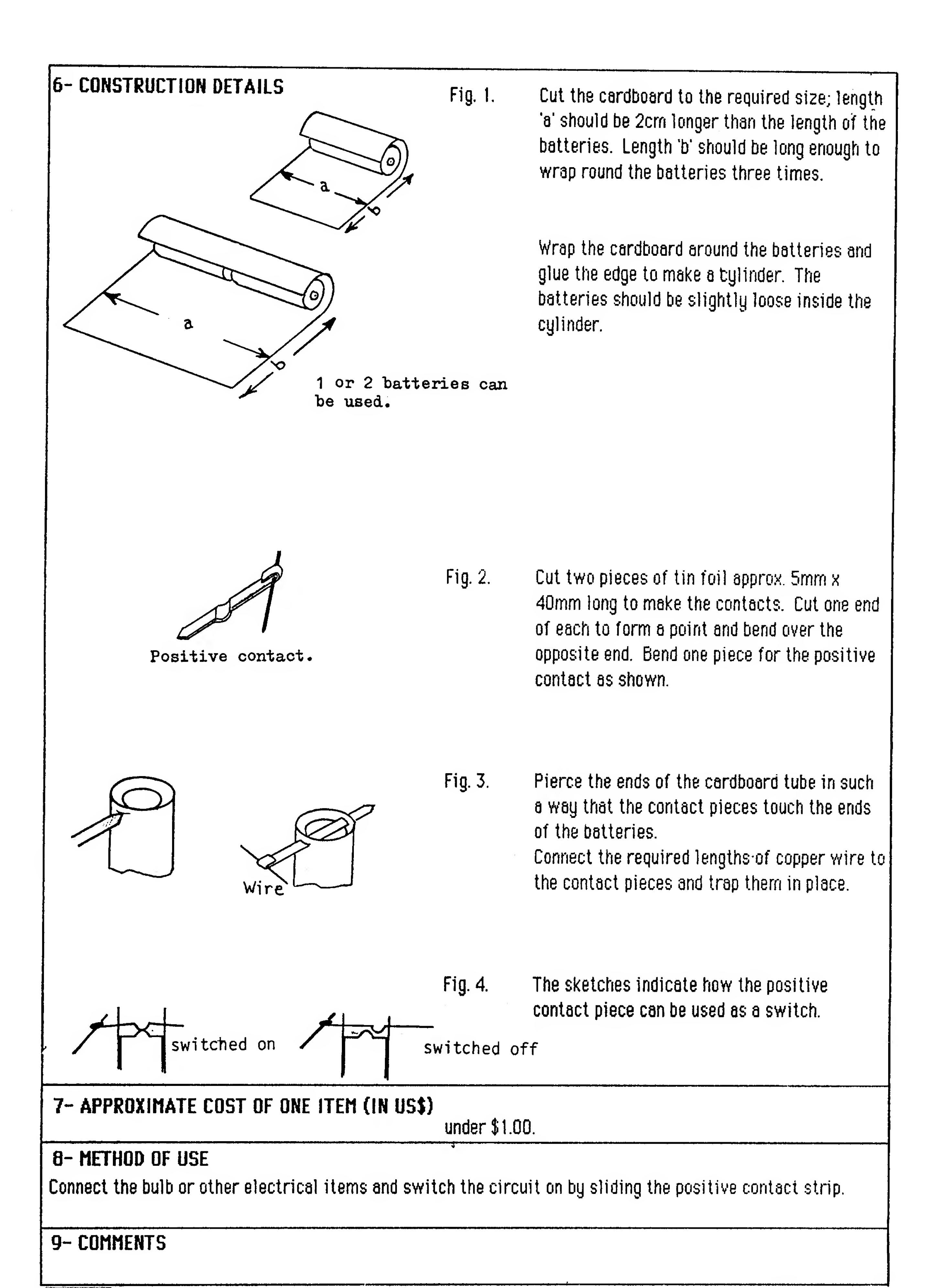


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Cylinder.	1.	Rectangular Cardboard Sheet.	Length long enough to wrap up 1 or 2 batteries, plus 2cm. Width long enough to wrap round the batteries 3 times.
2 - Contacts.	2.	Tin foil (stiff).	0.5cm x 4cm long.
3 - Connecting wire.	2.	Copper wire (20 gauge) without enamel coating)	2 cm. long.



6- CONSTRUCTION DETAILS

Fig. 1. Cut the cardboard to the required size; length 'a' should be 2cm longer than the length of the batteries. Length 'b' should be long enough to wrap round the batteries three times.

Wrap the cardboard around the batteries and glue the edge to make a tylinder. The batteries should be slightly loose inside the cylinder.

Fig. 2. Cut two pieces of tin foil approx. 5mm x 40mm long to make the contacts. Cut one end of each to form a point and bend over the opposite end. Bend one piece for the positive contact as shown.

Fig. 3. Pierce the ends of the cardboard tube in such a way that the contact pieces touch the ends of the batteries.
Connect the required lengths of copper wire to the contact pieces and trap them in place.

Fig. 4. The sketches indicate how the positive contact piece can be used as a switch.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

under $1.00.

8- METHOD OF USE

Connect the bulb or other electrical items and switch the circuit on by sliding the positive contact strip.

9- COMMENTS

1- ITEM

SIMPLE SWITCH.

2- PURPOSE

For completing and breaking low voltage electrical circuits.

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project.
National Institute of Science and Technology. Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

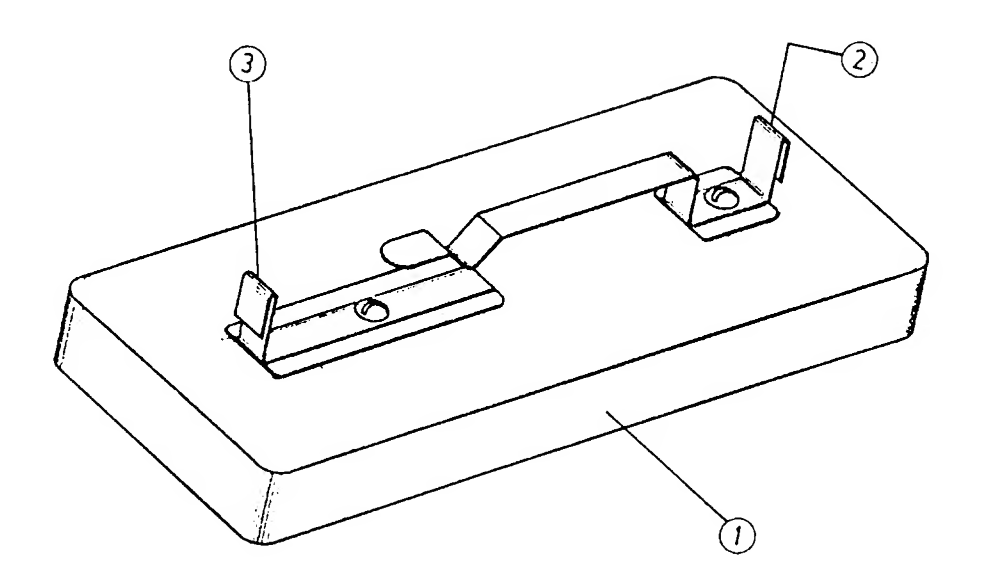


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Base.	1.	Plywood.	100mm x 40mm x 11mm.
2- Key.	1.	Paper fastener*.	Not critical.
3- Stationary Contact.	1.	Paper fastener*.	Not critical.

* The key and stationary contact can be cut from a single fastener. This may be a standard 70mm hole-to-hole fastener.

6- CONSTRUCTION DETAILS

Fig.1.

Drill the two holes at the distances shown and then cut the fastener at the places indicated to provide the key and the stationary contact.

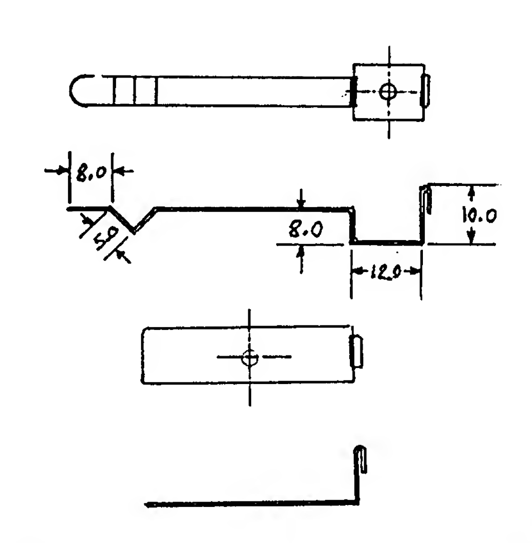


Fig.2. To form the key bend the parts as indicated in Fig.2.

Fig.3. To form the stationary contact bend the parts as indicated in Fig.3.

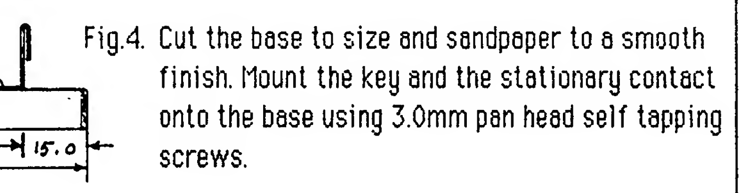


Fig.4. Cut the base to size and sandpaper to a smooth finish. Mount the key and the stationary contact onto the base using 3.0mm pan head self tapping screws.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50.

8- METHOD OF USE

Use wire leads with alligator clips to connect the switch to the circuit.

9- COMMENTS

If the base is to be varnished this should be carried out before screwing the contacts to the base. The switch is for use with low voltage battery circuits only.

1- ITEM

ELECTROSCOPE

2- PURPOSE

Principle of Static Electricity.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre, Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

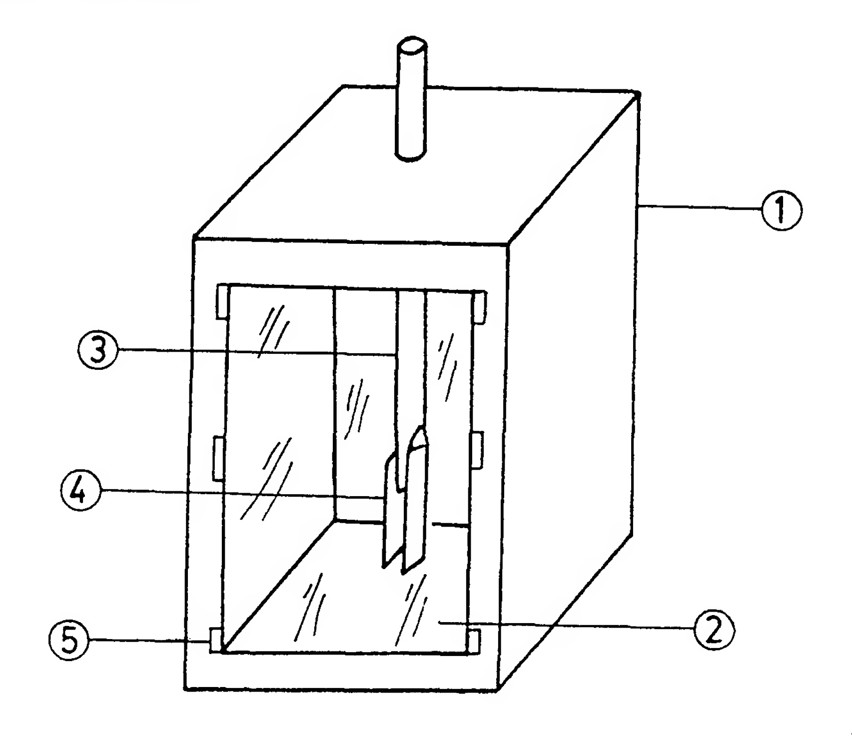


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Case.	1.	Cardboard Box.	80mm x 50mm x 50mm
2 - Window.	1.	Transparent Plastic Sheet.	70mm x 40mm
3 - Support rod.	1.	Aluminium Rod.	3mm dia. x 60mm long.
4 - Leaf.	2.	Aluminium Thin Foil.	10mm x 5mm
	1.	Plastic Sheet.	100mm x 100mm
	1.	Plastic Rod.	10mm dia. x 150mm long.
		Scotch Tape.	

Tools: Scissors, hammer, Bradawl.

6- CONSTRUCTION DETAILS

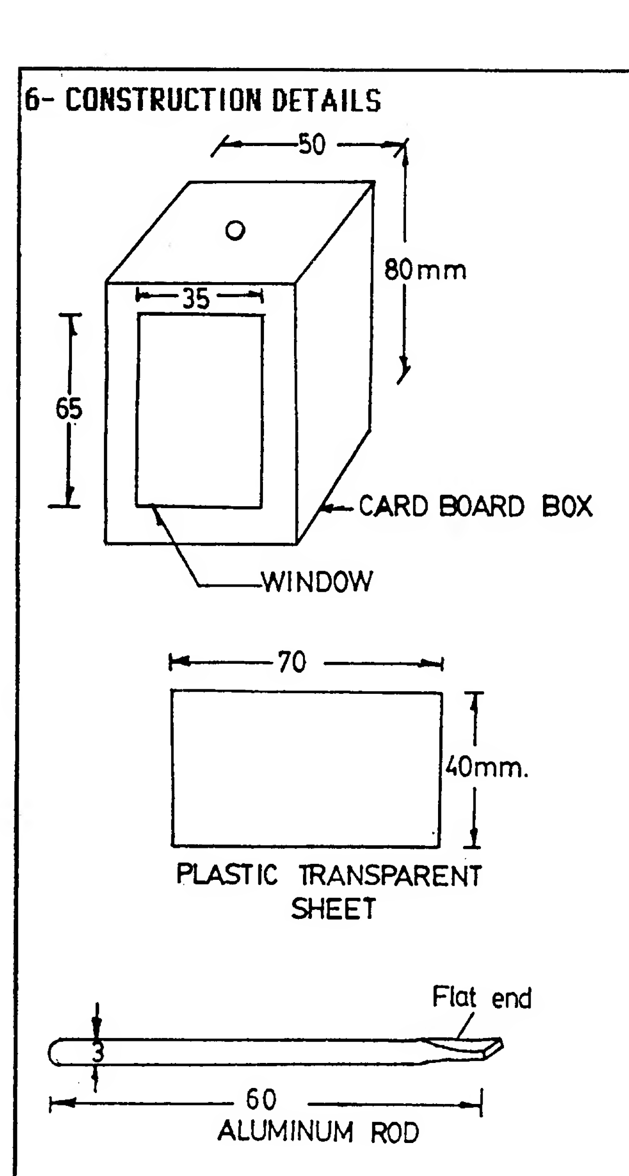


Fig. 1. Take a cardboard box of 80mm x 50mm x 50mm size, and with the help of the scissors, cut a window of 65mm x 35mm size.
With the help of the bradawl make a hole in the top of the box of 3mm dia.

Fig. 2. To cover the window, using the scissors cut a transparent plastic sheet to a size of 70mm x 40mm.

Fig. 3. Take an aluminium rod of 3mm dia. x 60mm long and, with the help of the hammer, flatten one end of the rod.

10 x 5mm

Fig. 4. Take the aluminium foil and, with the help of the scissors, cut two leaves of size 10mm x 15mm each.
Fix the aluminium leaves to the flat end of the rod, with the help of the scotch tape, in such a way that the surfaces of the leaves are parallel to one another. Locate the rod and leaf assembly inside the box as shown in Fig. A. and fix in place. Using scotch tape fix the transparent sheet at the window of the box.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.00.

8- METHOD OF USE

Discharge the apparatus by touching the aluminium rod with your fingers. Rub the plastic rod on the plastic sheet and bring near to aluminium rod. The aluminium leaves will move apart due to static electricity.

9- COMMENTS

1- ITEM

ELECTROSCOPE.

2- PURPOSE

Performing elementary experiments on electrostatics.

3- INFORMATION SUBMITTED BY

FUNBEC, Brazil.

4- LINE DRAWING OF PROTOTYPE

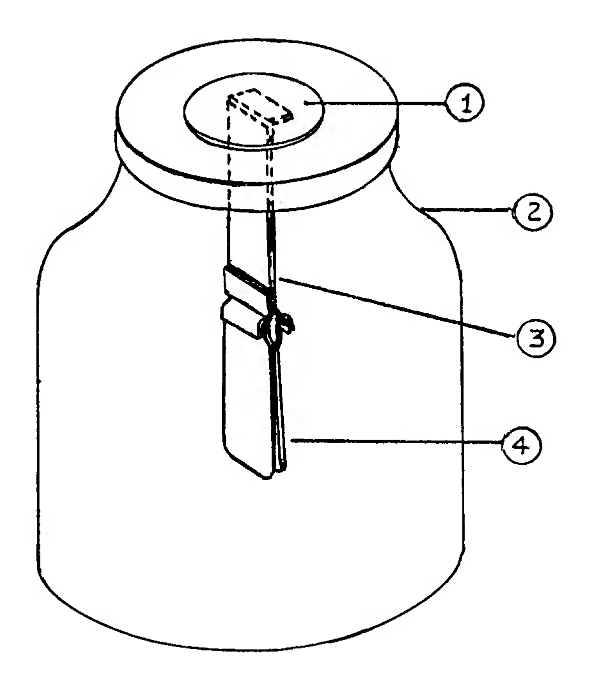


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Charge Plate.	1.	Coin or metallic disk.	3cm dia.
2- Receptacle.	1.	Flask with large mouth and plastic cap.	approx. 5cm dia and 8cm high.
3- Deflecting leaves support.	1.	Metal strip and copper wire.	4cm x 1cm x 0.05cm. 0.5mm dia x 6cm long.
4- Deflecting leaves.	2.	Aluminium foil.	4cm x 1cm x 0.005cm.

6- CONSTRUCTION DETAILS

1 cm

2,5 cm

1,5 cm

Fig. 1. To make the leaf support take the metal strip and round all the edges as shown. Bend one end into an 'L' shape and the other end into a 'U' shape.

aperture of 1,5 mm

Fig. 2. Using the copper wire construct a double rectangular coil as indicated, leaving a gap of 1.5mm between the two bottom long sides. The inside length of the bottom sides should be at least 1cm.
Hang the coil arrangement in the 'U' shape of the leaf support and close the 'U' as shown in Fig. 3.

deflecting leaves support

Fig. 3. To construct the leaves carefully round the corners of the foil and then bend the foil to the shapes indicated in Fig. 3.

Take the plastic cap of the flask and cut a 1cm. length slot in the centre. Introduce the 'L' shaped end of the leaf support into this slot such that the support hangs from the lid.
Gently hang the leaves on the leaf support as indicated in Fig. 3.

To complete the construction replace the cap onto the flask and locate the metal disc over the exposed metal part of the leaf support, ensuring a good metal contact.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

under $1.00.

8- METHOD OF USE

As for all electroscopes.

9- COMMENTS

1- ITEM

MODEL FOR THE DETERMINATION OF THE POLES OF A MAGNET.

2- PURPOSE

To determine the north and south poles of a magnet.

3- INFORMATION SUBMITTED BY

National Workshop for the Production of Low Cost Teaching Aids,
National Educational Equipment Centre. Lahore 16, Pakistan.

4- LINE DRAWING OF PROTOTYPE

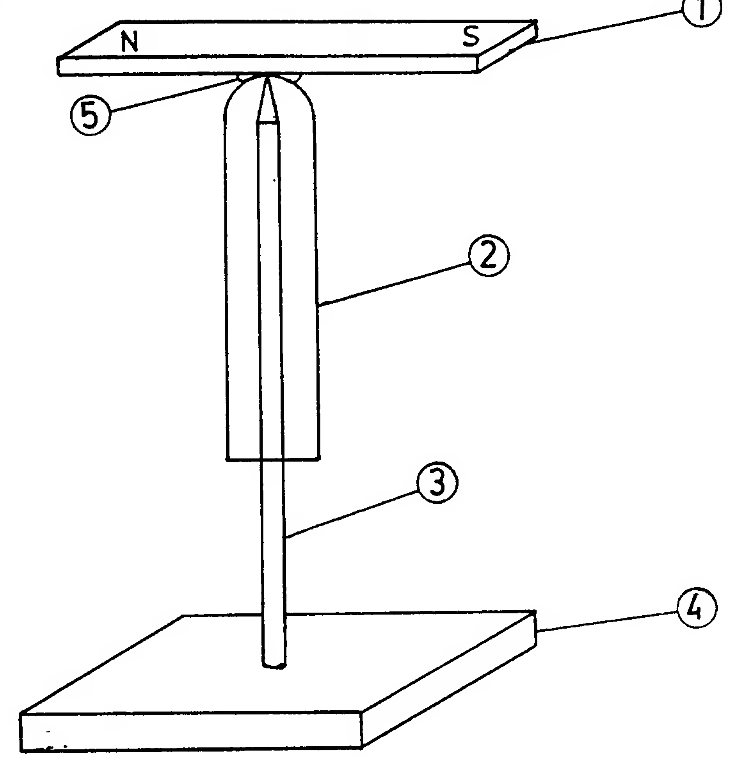


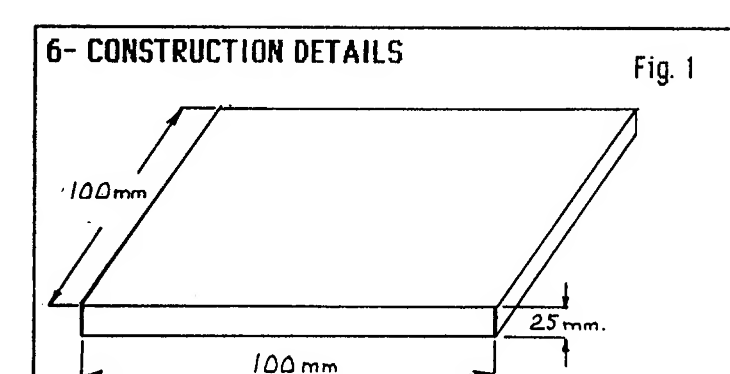
FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 -Magnet.	1.	Bar magnet.	80mm x 10mm x 5mm.
2- Magnet support.	1.	Test tube. (glass)	small size.
3- Pivot.	1.	Lead pencil.	---
4- Base.	1.	Styrofoam sheet.	100mm x 100mm x 25mm
		Clay or plasticine.	
		Tools: knife; hammer.	

6- CONSTRUCTION DETAILS

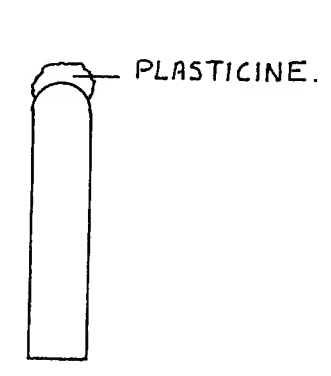
Fig. 1



Using a sharp knife cut a piece of styrofoam to the sizes indicated in the sketch.

Make a hole in the centre of the base to take the pencil. The pencil should be sharpened to a fine point.

Fig. 2.



Place some plasticene or clay on the end of the test tube. Press the magnet onto the plasticene so that it is evenly balanced on the top of the test tube.

Complete the assembly as indicated in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.50.

8- METHOD OF USE

The magnet will be in a north-south position once it has come to rest.

9- COMMENTS

The magnet mounted on the test tube may tilt during rotation. A possible modification would be to insert a piece of styrofoam into the test tube such that the point of the pencil is located in the styrofoam.

1- ITEM

MAGNETIC COMPASS.

2- PURPOSE

To determine the presence and direction of magnetic fields.

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project,
National Institute of Science and Technology, Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

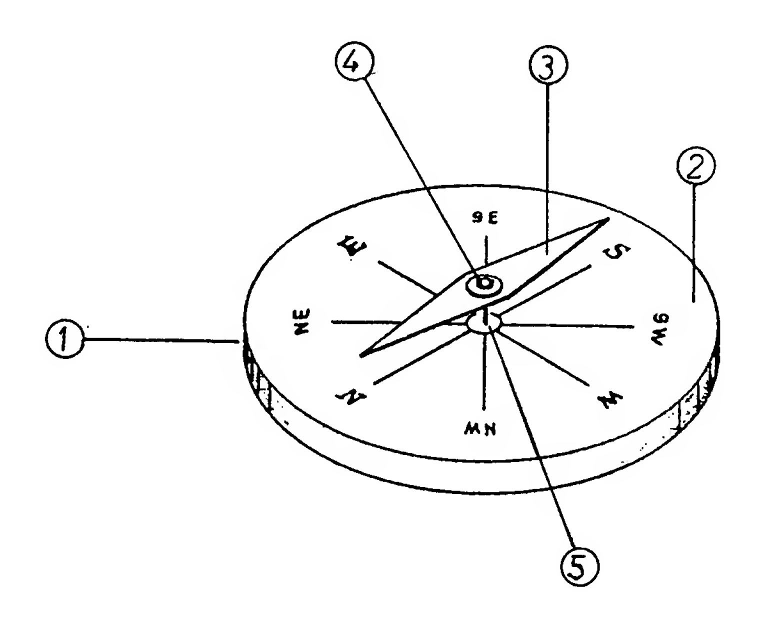
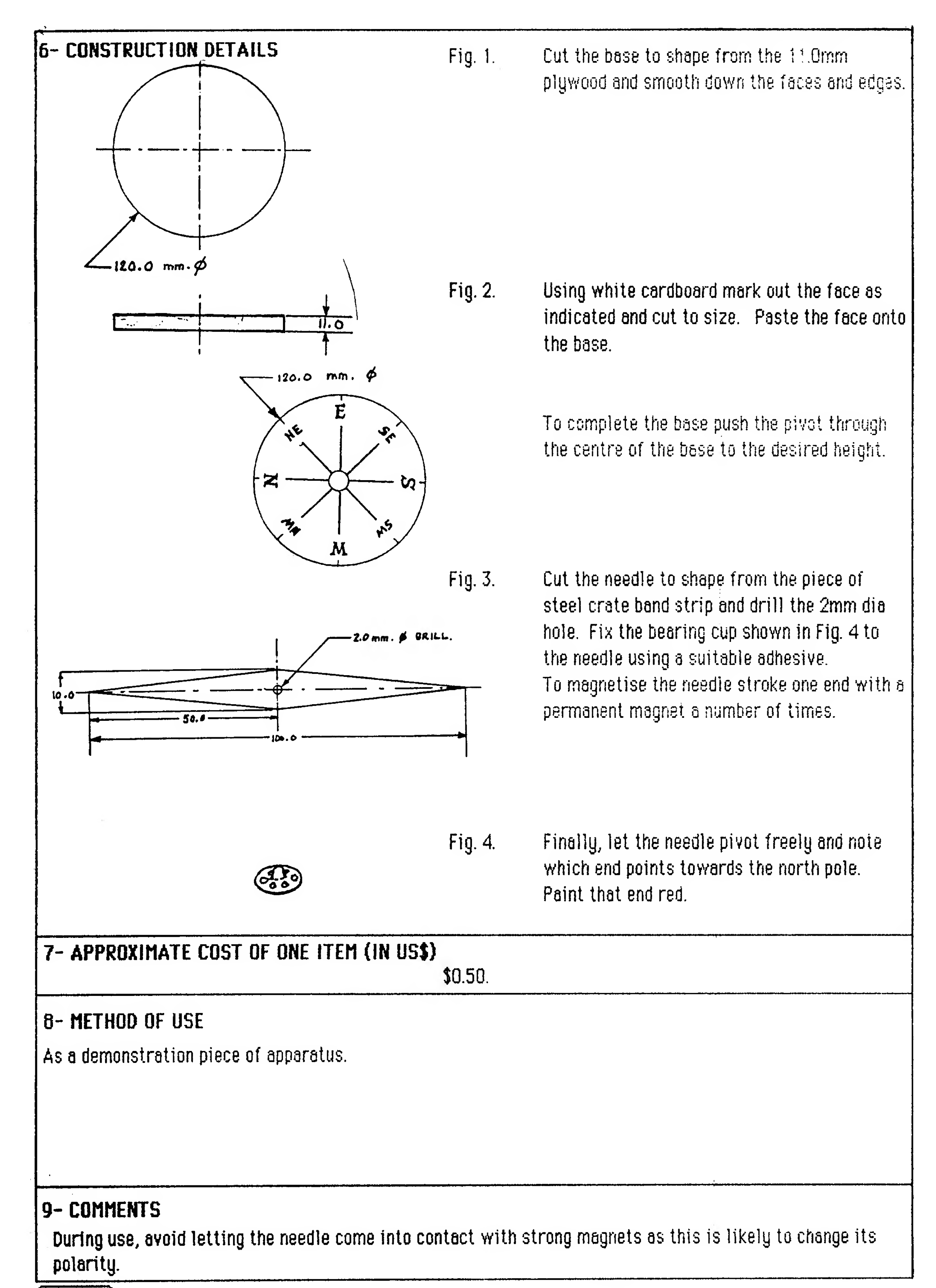


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Base.	1.	Plywood.	120mm dia x 11mm thick
2 - Face Card.	1.	Cardboard.	120mm dia.
3 - Needle.	1.	Strip metal (crate band).	160mm long.
4 - Bearing cup.	1.	Clothes snap (press stud socket).	approx. 6.0mm outside diameter.
5 - Pivot	1.	Clothes pin.	25mm long.



6- CONSTRUCTION DETAILS

Fig. 1. Cut the base to shape from the 11.0mm plywood and smooth down the faces and edges.

Fig. 2. Using white cardboard mark out the face as indicated and cut to size. Paste the face onto the base.

To complete the base push the pivot through the centre of the base to the desired height.

Fig. 3. Cut the needle to shape from the piece of steel crate band strip and drill the 2mm dia hole. Fix the bearing cup shown in Fig. 4 to the needle using a suitable adhesive.
To magnetise the needle stroke one end with a permanent magnet a number of times.

Fig. 4. Finally, let the needle pivot freely and note which end points towards the north pole. Paint that end red.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$0.50.

8- METHOD OF USE

As a demonstration piece of apparatus.

9- COMMENTS

During use, avoid letting the needle come into contact with strong magnets as this is likely to change its polarity.

1- ITEM

SIMPLE COMPASS GALVANOMETER.

2- PURPOSE

To show the principle of operation of a galvanometer.

3- INFORMATION SUBMITTED BY

FUNBEC, Brazil.

4- LINE DRAWING OF PROTOTYPE

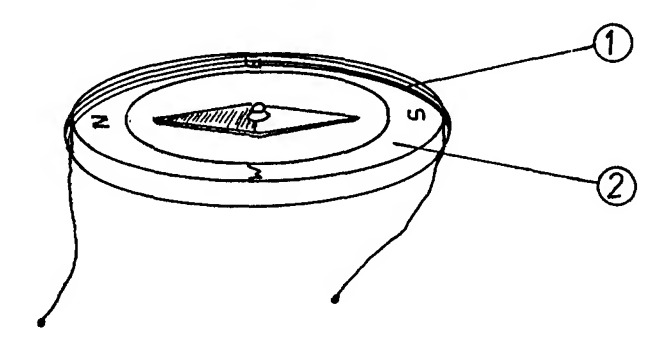


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Coil.	1.	Enamelled copper wire.	0.3mm dia x 2m long.
2- Compass	1.	Compass.	approx. 4cm dia.

6- CONSTRUCTION DETAILS

Wind the copper wire around the compass making approximately 15 elliptical turns with the longer axis parallel to the needle, whilst the needle is lined up with the N-S direction.

Fix the coil to the compass case using scotch tape. Remove the enamel insulation from the ends of the leads from the coil.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

Under $1.00.

8- METHOD OF USE

Connect the instrument in series with an ammeter and in parallel with a voltmeter. Draw a graph of the deflections for current or voltage.

When in use the coils should always lie in a N-S direction.

9- COMMENTS

The compass can be replaced by a magnetic needle suspended by a piece of string and with one end fixed to the coil.

1- ITEM

SIMPLE GALVANOSCOPE (GALVANOMETER).

2- PURPOSE

For detecting the presence of an electric current.

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project,
National Institute of Science and Technology, Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

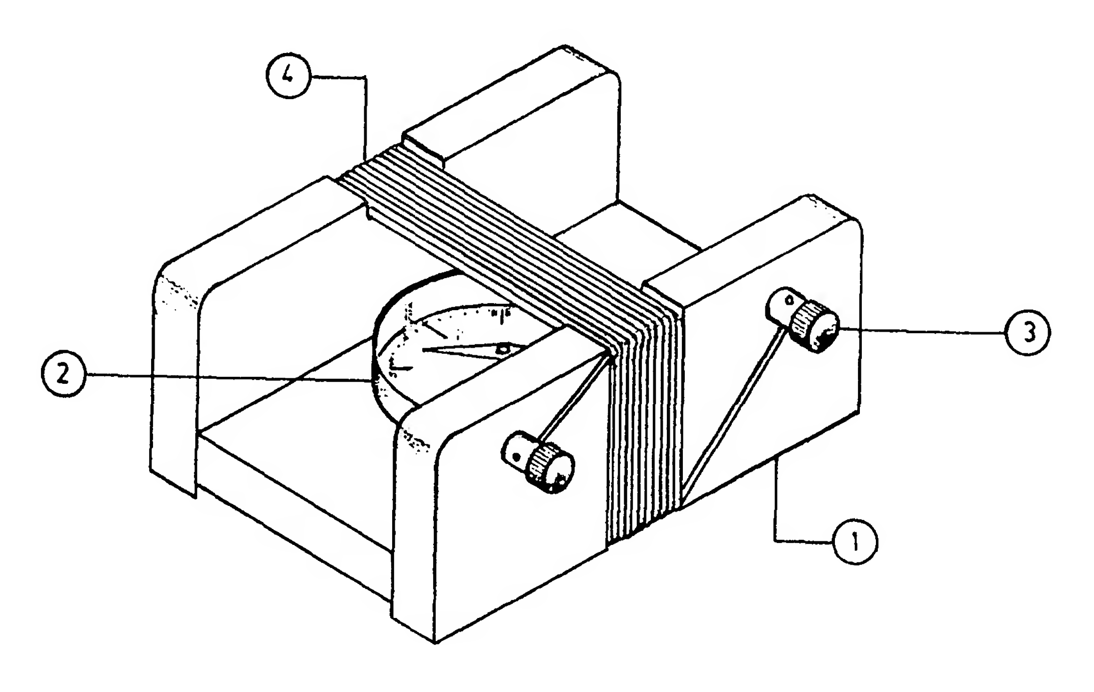


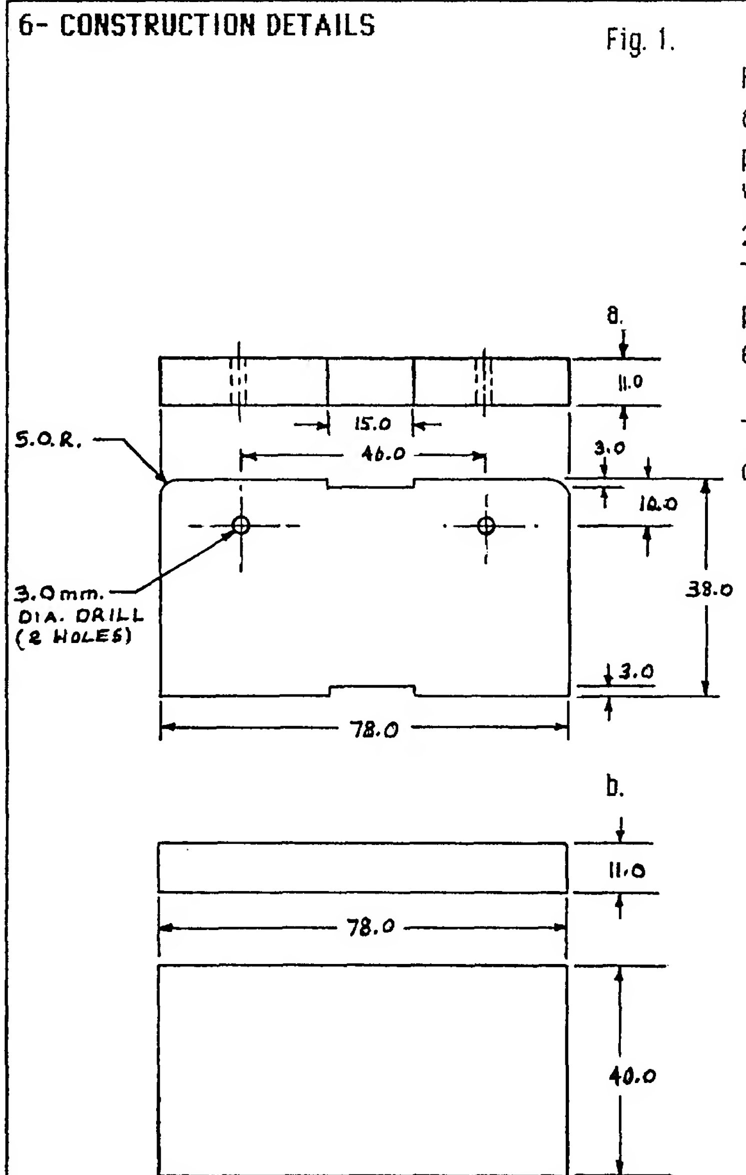
FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Frame.	1.	Plywood.	1 piece. 78mm x 40mm x 12mm. 2 pieces 78mm x 38mm x 12mm.
2 - Current indicator.	1.	Compass.	35mm dia.
3 - Binding post.	2.	Binding post or bolt and two nuts.	3mm dia. x 20mm.
4 - Coil.	1.	Magnet wire (insulated copper wire).	24 gauge x 0.5m.

6- CONSTRUCTION DETAILS

Fig. 1.



Prepare two pieces of plywood, as shown in 1.a. and one piece as shown in 1.b. Assembly these pieces with nails and glue to form the frame. Wind about 25 turns of insulated copper wire of 24 gauge around the slots provided in the frame. Terminate the ends of the wire to the binding posts after scraping off the insulation from the ends of the wire.

To complete the apparatus place the pocket compass inside the coil as indicated in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

$1.50.

8- METHOD OF USE

Connect the apparatus in series in a low voltage circuit.
In use, orientate the frame with the North-South direction so that, without connection to the circuit, the compass needle is parallel with the coil. Application of the current will make the needle rotate so that it is at an angle to the coil.

9- COMMENTS

1- ITEM

GALVANOMETER.

2- PURPOSE

To indicate the strength of an electrical current produced by chemical action in a battery.

3- INFORMATION SUBMITTED BY

Science Equipment Centre, Lagos, Nigeria.

4- LINE DRAWING OF PROTOTYPE

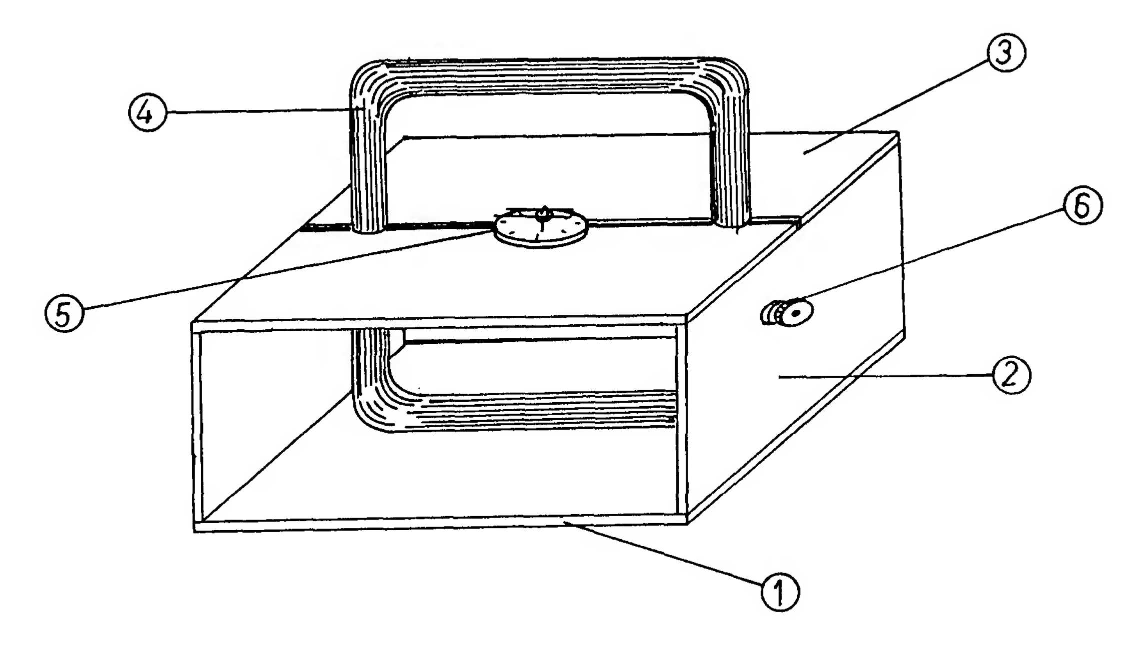


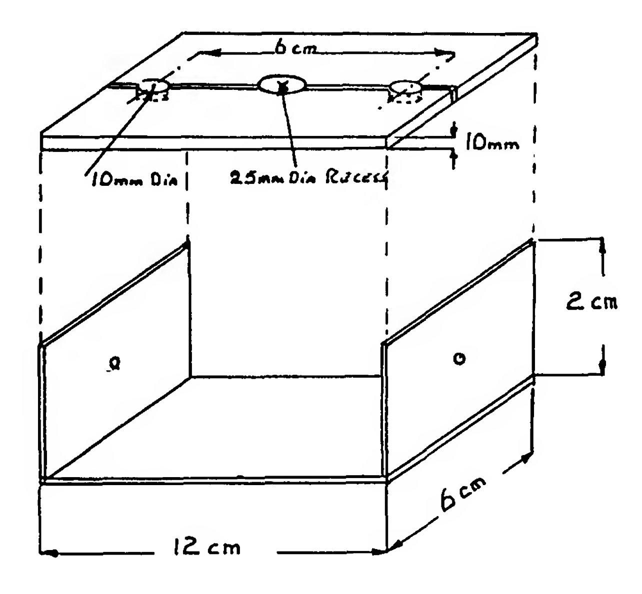
Fig. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Support Base.	1.	Plywood.	12cm x 6cm x 10mm.
2 - Support sides.	2.	Plywood.	6cm x 2cm x 10mm.
3 - Platform.	1.	Plywood	12cm x 6cm x 10mm
4 - Coil.	1.	Copper wire.	24 gauge.
5 - Compass.	1.	As available (or constructed using a wood disc, three needles and a press stud).	
6 - Terminals.	2.	Brass bolts and nuts (4)	
		Woodscrews.	
	18.	Varnish.	

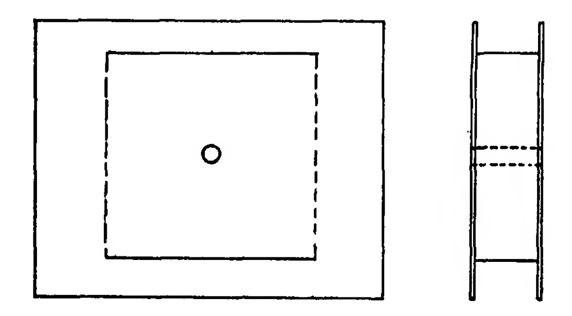
6- CONSTRUCTION DETAILS

Fig. 1.



Construct an open ended box as shown in the sketch. Drill a hole in the centre of each side piece to take the brass terminal bolts, then screw the sides to the base. Before fixing the lid drill two 1cm dia. holes, and a recess of 2.5cm. Then saw the lid in half along the centre line of the holes and recess. Screw the rear half of the lid to the sides.

Fig. 2.



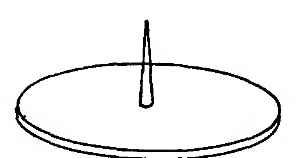
To make the coil first construct a former on which to wind the coil by taking a piece of wood of size 5cm x 5cm x 1cm. Cut two pieces of stiff cardboard of approx. 1cm x 10cm, then drill a hole through the centre of the cardboard pieces and the wooden block. Join them together, as indicated in the sketch, using a bolt and wing nut.

Wind 100 turns of the copper wire around the block applying varnish to each layer. Leave a length of 20cm at each end of the coil for making connections to the terminals.

Remove the coil from the former and locate in the box. Connect the coil to the brass terminals, each having two nuts on the outside of the box. Screw the front half of the lid in place.

6- CONSTRUCTION DETAILS (Continued)

Fig. 3.





If a suitable compass is not available construct one by first obtaining a wooden disc of approx. 2.5cm dia. Push a needle (or nail) up through the centre to make the pivot.

Take two steel needles and a large press stud and, using a suitable adhesive (or solder) fix the two needles parallel to one another, and at their point of balance, to the stud as indicated in the sketch. Using a magnet, stroke the needles to magnetise them.

Place the needles on the pivot and mark the North position on the disc. Then mark the other points as required.

To complete the apparatus place the compass in the recess in the lid of the box.

7- APPROXIMATE COST OF ONE ITEM (in US $)

8- METHOD OF USE

Align the coil with the compass needle. Connect the battery to the coil and observe the deflection. Reverse the polarity of the connections and again observe the deflection.

9- COMMENTS

To avoid the use of varnish when making the coil, cotton covered bell wire or other insulated copper wire of the required gauge could be used.

1- ITEM

ELECTRIC MOTOR.

2- PURPOSE

To show the basic components and principle of an electric motor.

3- INFORMATION SUBMITTED BY

FUNBEC, Brazil.

4- LINE DRAWING OF PROTOTYPE

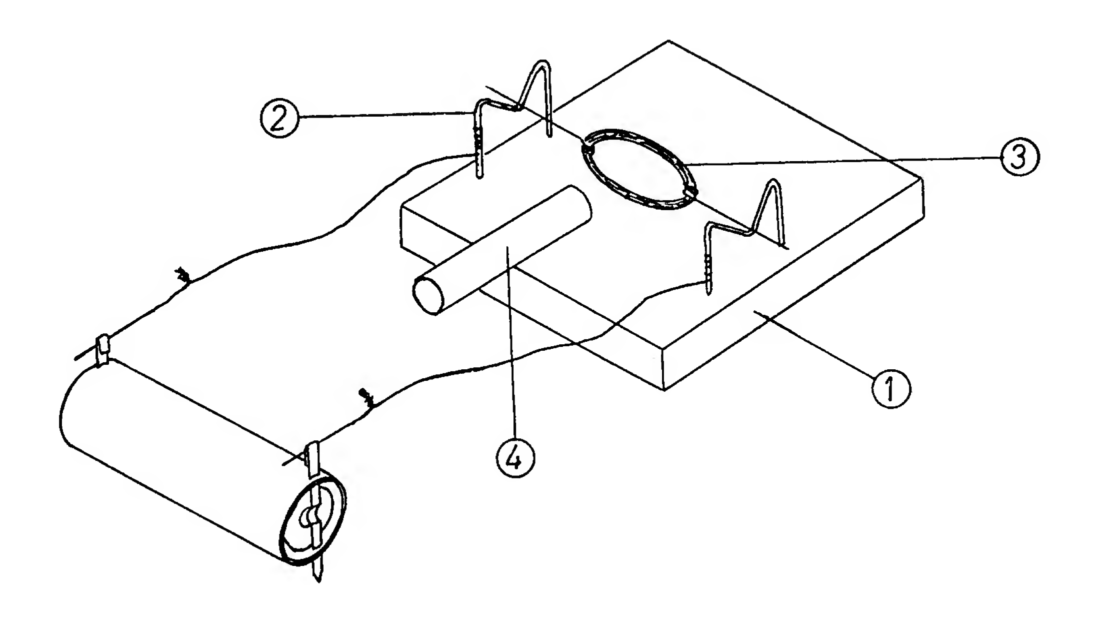


FIG. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1- Base-support.	1.	Polystyrene or soft wood.	10cm x 10cm x 2cm.
2- Support-hook.	2.	Wire or paper clip.	1mm dia x 8cm long.
3- Rotor-coil.	1.	Enamelled copper wire.	0.3mm dia x 2m long.
4- Magnet.	1.	Ceramic/Alnico Magnet.	1cm dia x approx 4cm.

6- CONSTRUCTION DETAILS

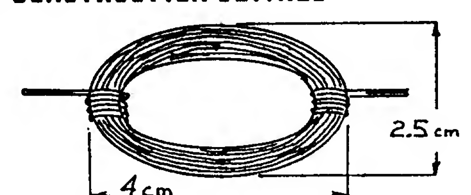
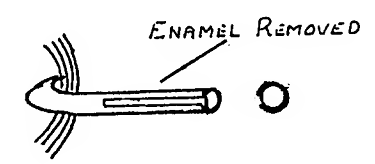


Fig. 1.

a. Wind the enamelled copper wire into a coil as indicated in 1.a.



b. With a sharp knife remove the enamel insulation for a short length at each end of the coil leads as in 1.b. When the coil is in the vertical position remove approx. one-sixth of the circumference, i.e. the coil movement would be approx 60° with the bare copper still in contact with the support.

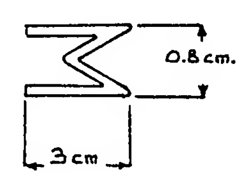


Fig. 2.

Using the wire (or paper clip) construct two support-hooks as indicated in the sketch.

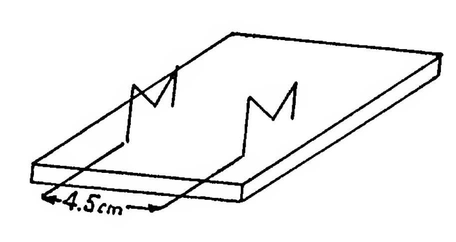


Fig. 3.

Fix the two support-hooks into the base at a distance of 4.5cm apart, and in line with one another. Place the coil onto the supports and adjust the supports and/or coil so that the coil balances and rotates freely. Connect two leads to the supports.

7- APPROXIMATE COST OF ONE ITEM (IN US$)

Under $1.00.

8- METHOD OF USE

Bring a magnet close to the coil and connect the battery leads as in Fig. A. Give a slight turn to the coil to commence rotation. If it does not rotate give a slight turn in the opposite direction. Change the polarity of the supply at the supports or change the pole of the magnet and note the change in direction of rotation. Relate the current direction to the magnetic field. Construct an electromagnet and use it in place of the permanent magnet. Change the position of the magnet and observe what happens.

9- COMMENTS

1- ITEM

SIMPLE D.C. ELECTRIC MOTOR.

2- PURPOSE

For showing the transformation of electrical energy to mechanical energy.

3- INFORMATION SUBMITTED BY

School Science Equipment Development Project,
National Institute of Science and Technology, Manila, Philippines.

4- LINE DRAWING OF PROTOTYPE

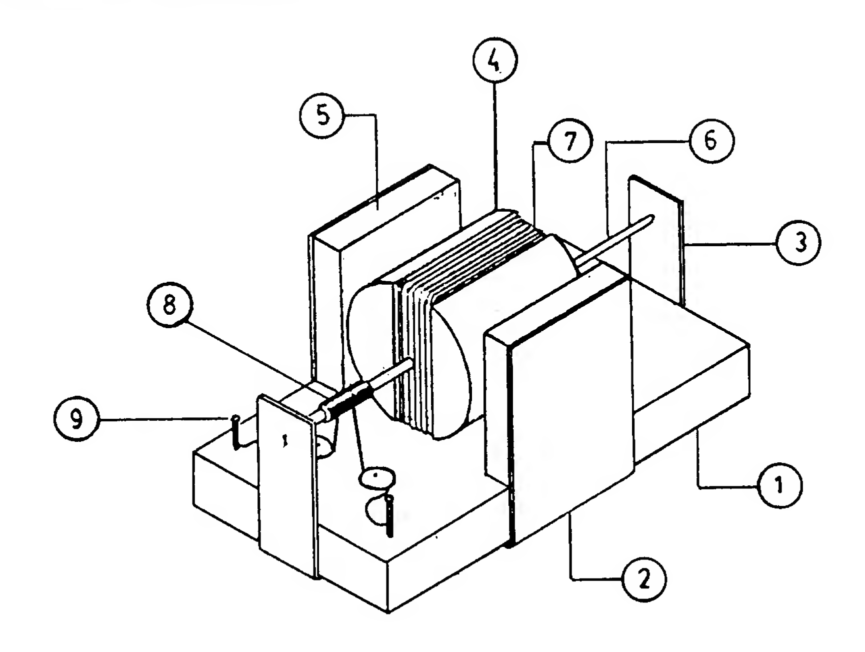


Fig. A.

5- MATERIALS FOR CONSTRUCTION

Components	Qty	Materials Required	Dimensions
1 - Base.	1.	Plywood.	80mm x 50mm x 10mm.
2 - Magnet holder.	1.	Mild steel sheet.	140mm x 28mm x 18 gauge.
3 - Armature support.	2.	Mild steel sheet.	52mm x 15mm x 18mm gauge.
4 - Armature.	1.	Wood.	32mm dia. x 30mm.
5 - Magnet.	1.	Ferrite magnet.	28mm x 28mm x 5mm.
6 - Motor shafting.	1.	Galvanised iron wire.	3mm dia. x 85mm.
7 - Motor winding.	1.	Magnet wire (insulated copper wire).	approx. 2500mm x 24 gauge.
8 - Commutator Insulator.	1.	Insulation from electric wire.	15mm length from 10 gauge wire.
9 - Binding post.	2.	Nail.	20mm long.

6- CONSTRUCTION DETAILS

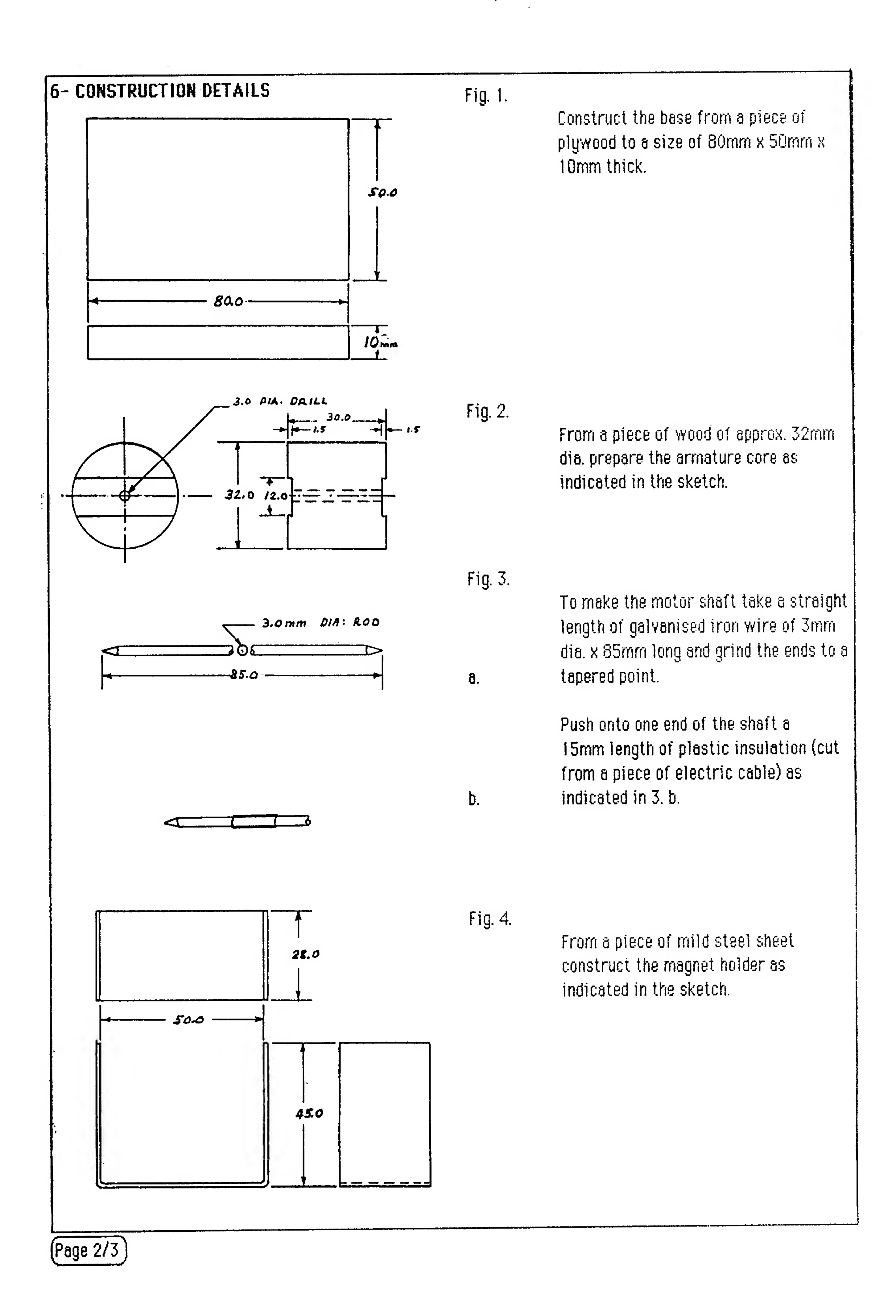


Fig. 1.

Construct the base from a piece of plywood to a size of 80mm x 50mm x 10mm thick.

Fig. 2.

From a piece of wood of approx. 32mm dia. prepare the armature core as indicated in the sketch.

Fig. 3.

a. To make the motor shaft take a straight length of galvanised iron wire of 3mm dia. x 85mm long and grind the ends to a tapered point.

b. Push onto one end of the shaft a 15mm length of plastic insulation (cut from a piece of electric cable) as indicated in 3. b.

Fig. 4.

From a piece of mild steel sheet construct the magnet holder as indicated in the sketch.

6- CONSTRUCTION DETAILS (Continued)

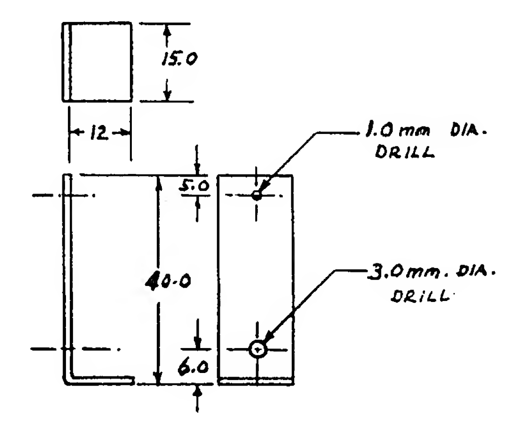


Fig. 5.

From a piece of mild steel sheet construct the armature support as indicated in the sketch.

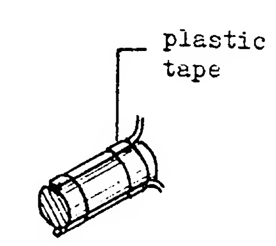


Fig. 6.

To assemble the armature push the shaft through the wooden armature core. Wind about 20 turns of 24 gauge enamelled copper wire around the length of the core bringing both ends out to the commutator insulator. Scrape off a length of the enamel from each end and tape the ends onto the insulator as shown in the sketch.

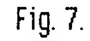
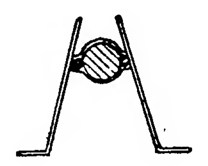


Fig. 7.



The brush contacts are made from two pieces of fine enamelled copper wire, fixed to the base by thumb tacks, and connected to the binding posts. Scrape off a length of the enamel insulation and arrange the contacts and commutator as shown in the sketch. Complete the assembly as indicated in Fig. A.

7- APPROXIMATE COST OF ONE ITEM (in US $)

$3.50.

8- METHOD OF USE

As a demonstration motor. Connect the binding posts to a low voltage source and commence the rotation by hand in the first instance.

9- COMMENTS

If the magnets (ferrite or alnico) available are of a different size to those indicated, then changes will be necessary for other component dimensions.